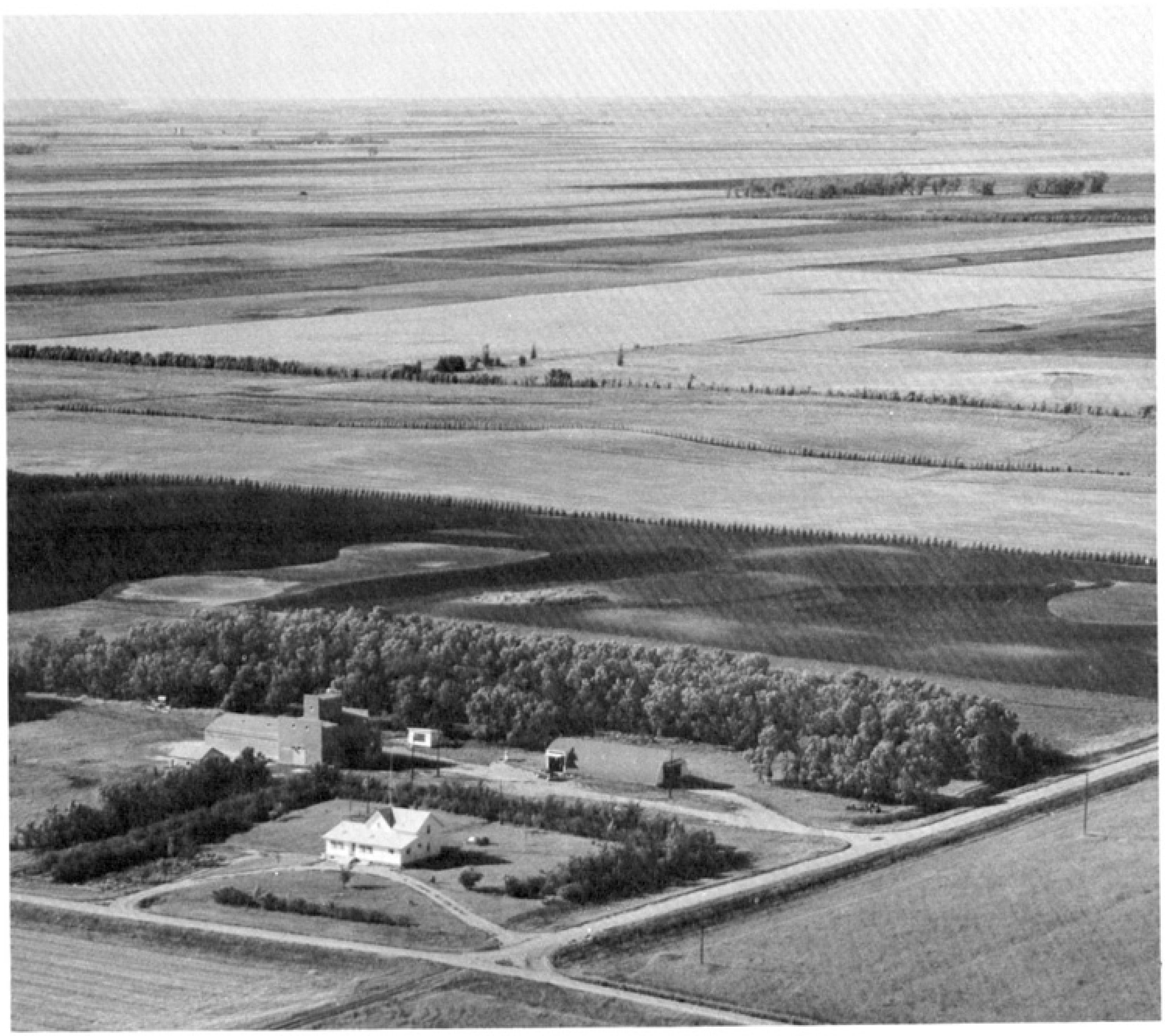
United States
Department of
Agriculture

Soil
Conservation
Service

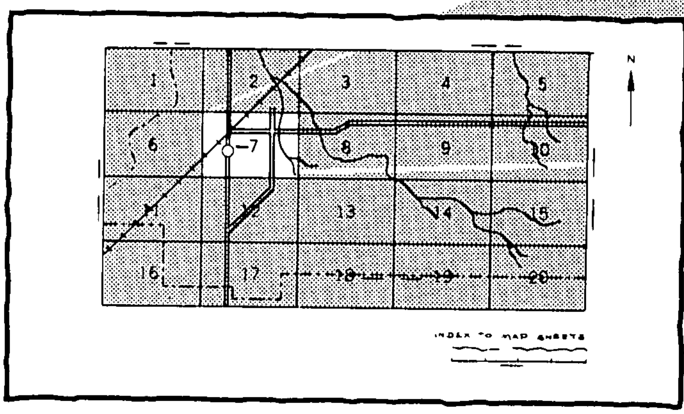
In cooperation with
North Dakota Agricultural
Experiment Station and
North Dakota State
Soil Conservation Committee

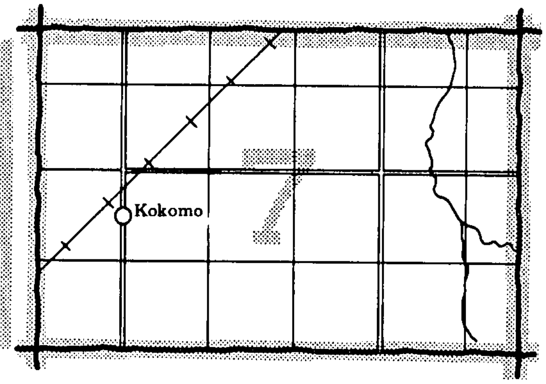
Soil Survey of Cass County Area North Dakota



HOW TO USE

1. Locate your area of interest on the "Index to Map Sheets."





2. Note the number of the map sheet and turn to that sheet.

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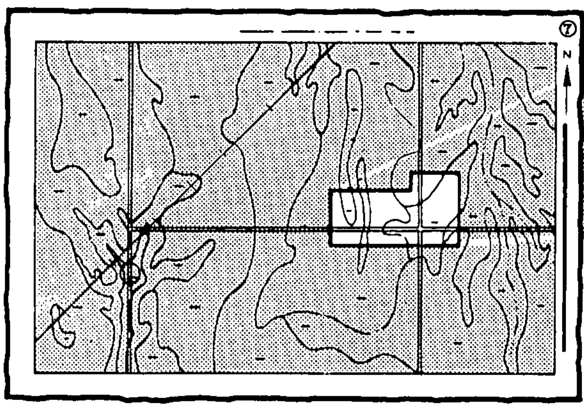

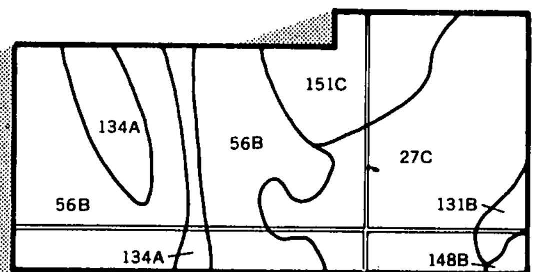

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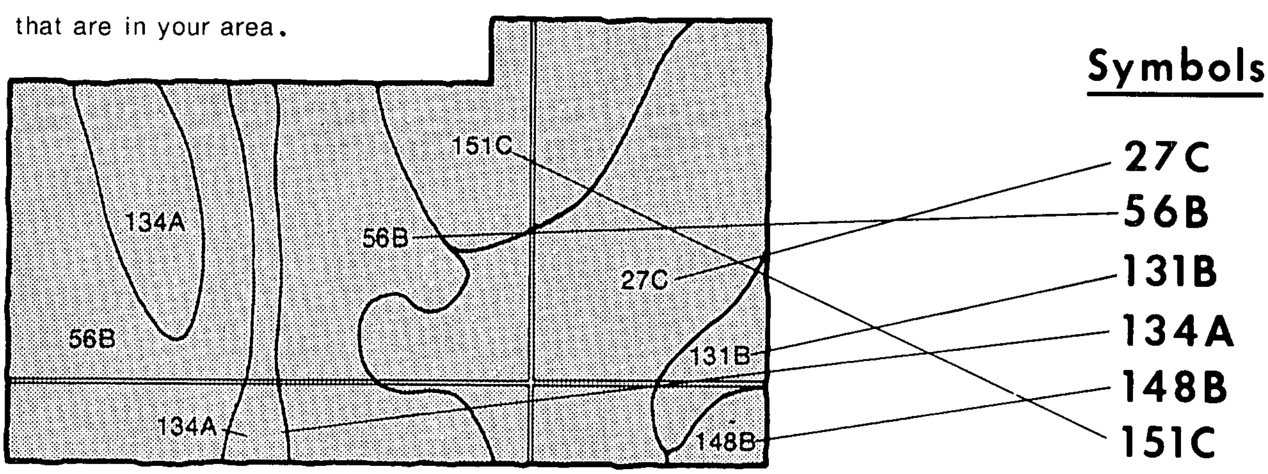
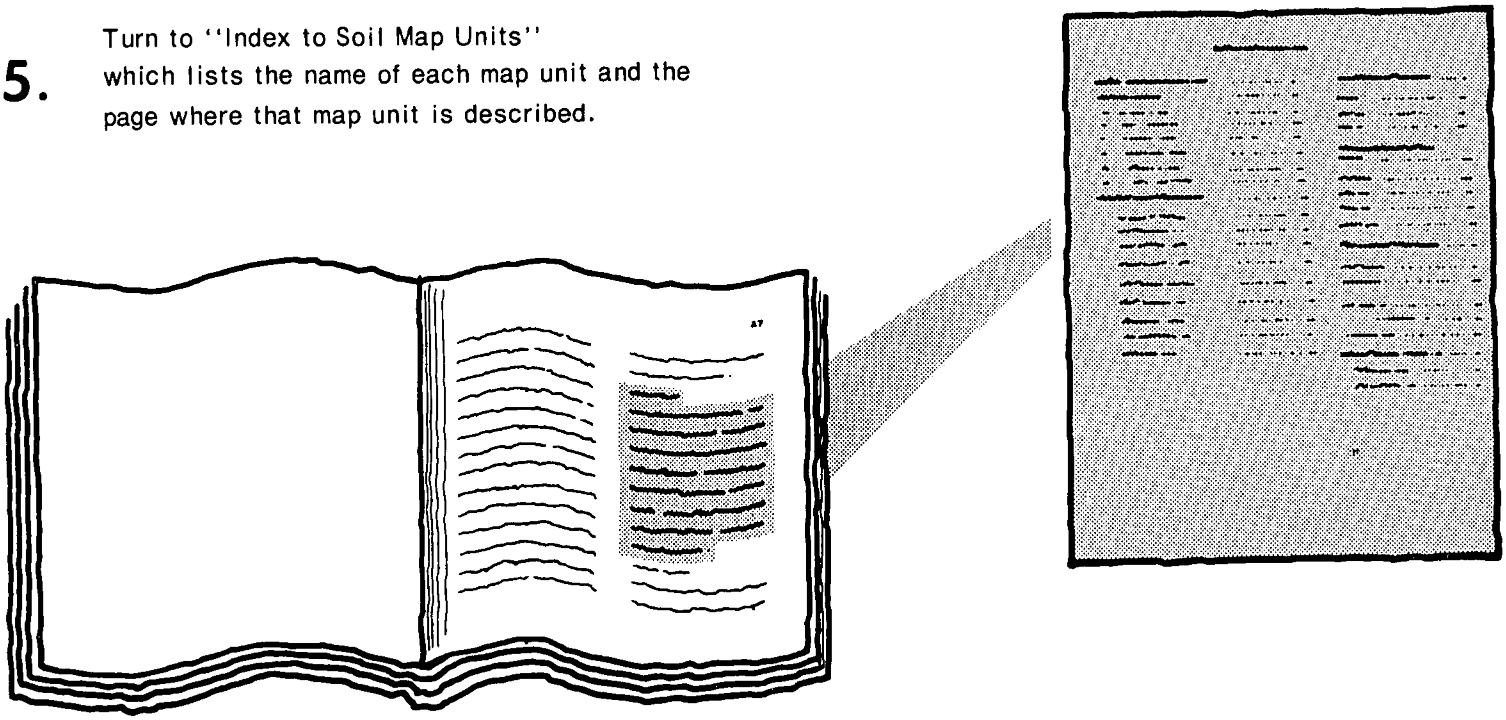
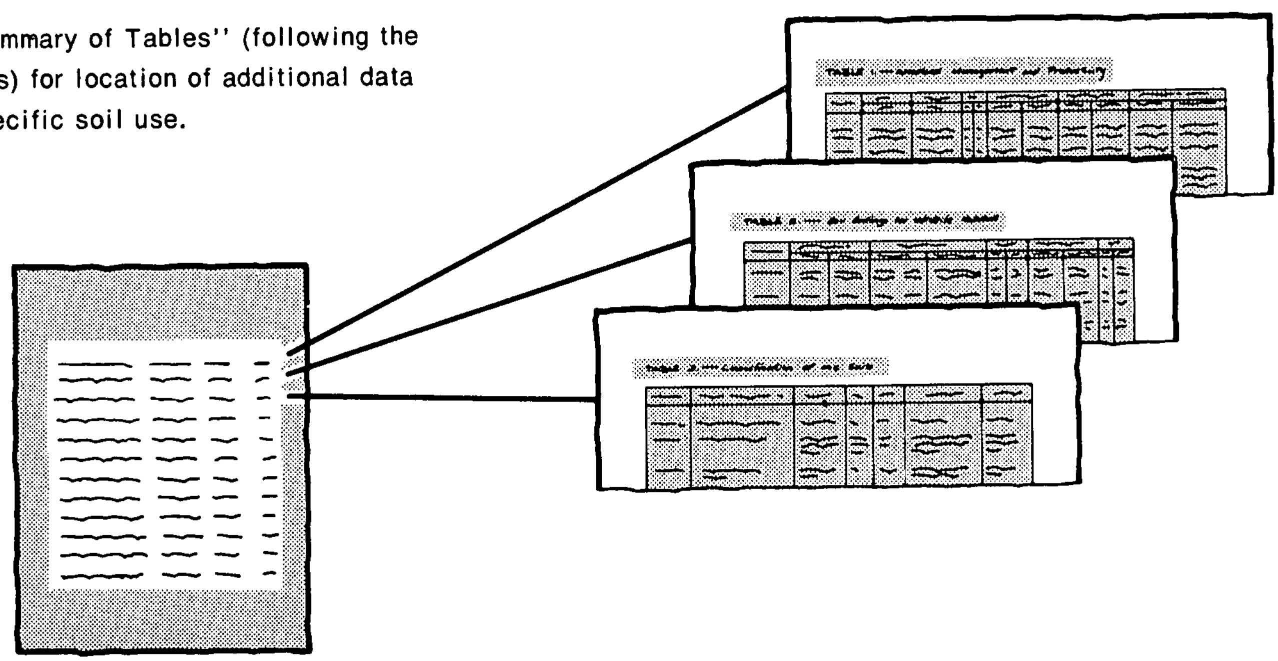


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in 1982. Soil names and descriptions were approved in 1983. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1982. This survey was made coöperatively by the Soil Conservation Service, the North Dakota Agricultural Experiment Station, and the North Dakota State Soil Conservation Committee. It is part of the technical assistance furnished to the Cass County Soil Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Windbreaks in an area of the Hamerly-Tonka-Wyard association. The trees help control soil blowing, protect farmsteads and livestock, provide wildlife habitat, and beautify the landscape.

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Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in the Cass County Area. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

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Soil Survey of
Cass County Area, North Dakota

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United States Department of Agriculture, Soil Conservation Service
In cooperation with the North Dakota Agricultural Experiment Station
and the North Dakota State Soil Conservation Committee

Cass County is in the southeastern part of North Dakota (fig. 1). The survey area takes in 913,280 acres, or 1,427 square miles. The area is bordered on the east by the Red River of the North. Fargo, the county seat, is on the eastern boundary about halfway between the northern and southern boundaries.

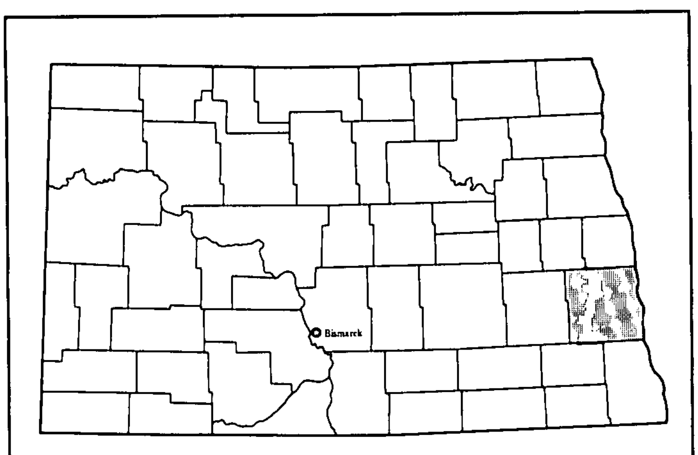

Figure 1.—Location of Cass County in North Dakota. The unshaded area was surveyed in 1966.

Farming is the main economic enterprise. The principal crops are spring wheat, barley, sunflowers, sugar beets, corn, and soybeans.

All of the soils in the survey area are deep. They are suited to cultivated crops and to pasture and hay. Poor surface drainage in level and depressional areas of soils that are poorly drained and very poorly drained is a major concern in management, especially during wet periods. Soil blowing is a hazard on sandy soils, on some loamy soils, and on calcareous clayey and silty soils. About 30,000 acres of soil is moderately saline or alkali (sodic). The sandy and gravelly soils on beaches have a very low or low available water capacity.

General Nature of the Survey Area

This section provides general information about the survey area. It describes climate, history and development, water supply, transportation, and physiography, relief, and drainage.

Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

The Cass County Area is usually quite warm in summer. There are frequent hot days and occasional cool days. Winters are very cold because of frequent blasts of artic air. Most precipitation falls during warm weather; therefore, it normally is heaviest late in spring

and early in summer. Snowfall, which normally is not too heavy, is blown into drifts; thus, much of the ground is free of snow.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Amenia, North Dakota, in the period 1951 to 1978. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 20 degrees F, and the average daily minimum temperature is 11 degrees. The lowest temperature on record, which occurred at Amenia on January 15, 1972, is -36 degrees. In summer the average temperature is 68 degrees, and the average daily maximum temperature is 82 degrees. The highest recorded temperature, which occurred on August 18, 1976, is 107 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 20 inches. Of this, 16 inches, or 80 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 13 inches. The heaviest 1-day rainfall during the period of record was 4.9 inches at Amenia on May 29, 1970. Thunderstorms occur on about 35 days each year, and most occur in summer.

The average seasonal snowfall is 31 inches. The greatest snow depth at any one time during the period of record was 23 inches. On the average, 55 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the north. Average windspeed is highest, 14 miles per hour, in spring.

Several times each winter, snow and high winds cause blizzard conditions in the area. Hail during summer thunderstorms occurs in small, scattered areas.

History and Development

Between 1870 and 1880, what is now Cass County and the surrounding area were part of a reservation that was inhabited by the Sisseton and Wahpeton bands of the Sioux Indians. The first white settlers entered the county in 1870, and by December of the following year they numbered 53. The land along the Red, Wild Rice, and Sheyenne Rivers was settled first. The settlers found wood and water in the river valleys and used the Red River to transport grain and supplies. The first post office was established at Centralia, North Dakota. In 1873 the name of Centralia was changed to Fargo in honor of Willard G. Fargo, a director of the Northern Pacific Railway Company and founder of the Wells-Fargo Express Company. Settlers began to enter Cass County at a rapid rate after the westward extension of the Northern Pacific Railway and the extension of the St. Paul & Pacific Railroad Company to Barnesville, Minnesota *(8)*.

By 1883 practically all the arable land in the county was settled. Up to that time, large tracts of virgin sod were broken each year and seeded to small grains or, more commonly, to flax. Spring wheat provided the first cash crop, and its high yield was largely responsible for the rapid settlement of the county *(8)*.

The average size of farms in Cass County in 1900 was 468 acres. The average size increased to 495 acres in 1910, but it declined to 421 acres in 1920 and to 403 acres in 1925. In 1978 there were 1,433 farms. The average size of these farms was about 781 acres.

In 1980, the population of Cass County was 88,247. Fargo is the largest city in the county. According to the 1980 census, it has a population of 61,308. Fargo is a trade, medical, educational, cultural, and agribusiness center. North Dakota State University, which has an annual enrollment of more than 8,000, is on the northwestern edge of the city. Other major towns and their populations in 1980 are Casselton, 1,661; Kindred, 568; Page, 329; Tower City, 293; and West Fargo, 10,099.

Water Supply

The water supply in the Cass County Area is from surface and ground water sources. The Red River of the North supplies water to Fargo. The main source in other areas is ground water. The principal sources of ground water are the Fargo, West Fargo, Page, Tower City, Bantel, and Sheyenne delta aquifers.

The West Fargo aquifer averages about 60 feet in thickness. The water is hard to very hard. The Page aquifer has an areal extent of about 155 square miles. The water quality is very hard and is classified as high salinity and low sodium content. The Bantel aquifer has an areal extent of about 9 square miles, and the Sheyenne River delta aquifer has one of about 60 square miles. The maximum thickness of the Sheyenne delta aquifer is about 120 feet, and the water is very hard. The Tower City aquifer is about 1/4 mile wide, and the water is hard.

Small, isolated aquifers, which range from a few feet to 20 feet in thickness, are common. The water quality varies, and the available quantity of water is small *(7)*.

Transportation

Interstate 29, U.S. Highway 81, and North Dakota Highways 18 and 38 are the major north-south routes in the county. Interstate 94 and North Dakota Highway 46 are the major east-west routes. These highways and the paved and gravelled county and township roads provide a good network of roadways. The county is also served by major air and rail lines.

Physiography, Relief, and Drainage

Cass County is in the Central Lowland Province. The eastern three-fourths of the county is in the Red River Valley (the Lake Agassiz Basin) physiographic division and the western one-fourth is in the Drift Prairie physiographic province *(6)*.

The flatness of the Red River Valley is broken by the escarpment of the Sheyenne River delta and the beaches of glacial Lake Agassiz. The Sheyenne delta covers an area of about 60 square miles in the south-central part of the county. Northeast of Leonard it rises 75 to 100 feet above the lake plain. To the west, it merges with the Maple River delta and the shore deposits of glacial Lake Agassiz. The surface of the Sheyenne delta is relatively flat, and local relief does not exceed 5 feet. Relief on the Maple River delta ranges from 5 feet per mile to 20 feet per mile.

The plain of Lake Agassiz is flat and nearly featureless. It has a northward slope of about 1 1/2 feet per mile and an eastward slope that ranges from 2 feet per mile near the Red River to 20 feet per mile farther west.

About 480 square miles in the western part of the county is a glaciated plain, which is interrupted only by minor glacial landforms and stream valleys. The land surface varies from strongly rolling to nearly flat. Relief generally ranges from 10 to 20 feet per mile, but in some areas it may be as much as 40 feet.

The Red River of the North flows along the eastern edge of the county and is the major stream in the area. Natural drainage in the lake plain is not well integrated, and a large part of the runoff is through manmade drains. The Sheyenne River enters the county about 1 mile southeast of Kindred and flows north for about 30 miles before emptying into the Red River north of Fargo. The Wild Rice River enters the county from the south and flows in a northeasterly direction for a distance of about 10 miles before entering the Red River south of Fargo.

Drainage in the Sheyenne and Maple deltas is largely subsurface. The surficial drainage pattern is poorly developed because soils and underlying deposits are highly permeable.

The Drift Prairie has mostly interior drainage. Small depressions collect runoff during periods of melting snow and heavy rainfall. The Drift Prairie is also drained by the Maple River, Swan Creek, and the south branch of the Goose River *(6)*.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they

compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

This soil survey updates the soil survey of Cass County published in 1924 *(8)*. It provides additional information on use of the soils, and the maps show the soils in greater detail.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

The section "Survey Procedures" explains specific procedures used to make this survey.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each map unit or association on the general soil map is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other associations but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The general soil map in this publication includes the Cass County Area and the Tri-County Area, an area that was previously mapped. A soil survey of the Tri-County Area was published in 1966.

In this publication, the general soil map associations in the Cass County Area and those in the Tri-County Area are described. Detailed descriptions, however, of some of the soils are included only in the soil survey of the Tri-County Area. Those soils are Aberdeen, Arveson, Eckman, Egeland, Fordville, Hamar, Hecla, LaPrairie, Spottswood, and Ulen soils.

Some of the boundaries on the general soil map in this publication do not match those on the soil map of Richland and Traill Counties, and some of the soil names and descriptions do not fully agree. The differences are a result of improvements in the classification of soils, particularly modification or refinements in soil series concepts. Also, there may be differences in the intensity of mapping or in the extent of the soils within the survey area.

Soil Descriptions

Level to moderately steep, medium textured and moderately fine textured soils that formed in glacial till and in alluvium over glacial till; on glacial till plains

The texture of the materials these soils formed in includes loam, clay loam, silt loam, silty clay loam, and fine sand. The soils make up about 24 percent of the county. In some areas, water flows to natural drainageways and streams, but in most areas it collects in shallow depressions. A few marshes, many depressions, numerous low knolls, and a few ridges are evident.

1. Barnes-Heimdal-Emrick Association

Deep, nearly level to moderately steep, well drained, medium textured soils

The soils that make up this association formed in glacial till. They are on foot slopes, side slopes, and low knolls of glacial till plains. The soils are mainly nearly level to moderately sloping. Those that are near drainageways and streams are strongly sloping and moderately steep.

This association makes up about 2 percent of the county. It is about 25 percent Barnes soils, 17 percent Heimdal soils, 9 percent Emrick soils, and 49 percent soils of minor extent.

The Barnes soils are well drained and are nearly level to moderately sloping. They are on side slopes and low knolls. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 7 inches thick. It is very dark grayish brown in the upper part and grayish brown in the lower part. The next layer, to a depth of 22 inches, is light yellowish brown loam. The substratum is light olive brown loam to a depth of 60 inches or more.

The Heimdal soils are well drained and are nearly level to strongly sloping. They are on side slopes and low knolls. Typically, the surface layer is black loam about 6 inches thick. The subsoil is loam about 26 inches thick. It is very dark grayish brown in the upper part, dark brown in the middle part, and light olive brown in the lower part. The substratum, which extends to a depth of 60 inches or more, is light olive brown. It is loam in the upper part and stratified sand in the lower part.

The Emrick soils are well drained and are nearly level and gently sloping. They are on foot slopes. Typically, the surface soil is black loam about 16 inches thick. The subsoil is loam about 12 inches thick. It is very dark grayish brown in the upper part and light olive brown in the lower part. The substratum is mottled light olive brown loam to a depth of 60 inches or more.

Svea, Esmond, Buse, Hamerly, and Maddock soils are of minor extent in this association. The Svea soils are moderately well drained and are on foot slopes and swales. They are dark in color to a depth of 16 inches or more. The Esmond soils are well drained and are on knolls and knobs. They have a loam surface layer and a fine sandy loam substratum. The Buse soils are well drained and are on knobs and knolls. Their surface layer and substratum are loam. The Hamerly soils are somewhat poorly drained and are on toe slopes. They have a layer of accumulated lime within a depth of 16 inches. The Maddock soils are well drained and on low ridges and knobs. They have a fine sandy loam surface layer and a loamy fine sand subsoil and substratum.

The soils in this association are used mainly for cultivated crops. They are suited to small grains and sunflowers. Irrigated corn and beans are grown in some places. Soil blowing and water erosion are the main concerns in management.

The slow permeability of the Barnes soils limits the use of the major soils in this association for septic tank absorption fields. Slope and shrink-swell potential commonly limit the use of these soils for building site development.

2. Barnes-Svea Association

Deep, level to moderately steep, well drained and moderately well drained, medium textured soils

The soils that make up this association formed in glacial till. They are on side slopes, low knolls, foot slopes, and in swales of glacial till plains. The soils are mainly level to strongly sloping. Water commonly flows to small depressions; however, where the soils are moderately steep, some water flows to drainageways and streams.

This association makes up about 6 percent of the county. It is about 32 percent Barnes soils, 30 percent Svea soils, and 38 percent soils of minor extent (fig. 2).

The Barnes soils are well drained and are nearly level to moderately steep. They are on low knolls and side slopes. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 7 inches thick. It is very dark grayish brown in the upper part and grayish brown in the lower part. The next layer, to a depth of 22 inches, is light yellowish brown loam. The substratum to a depth of about 60 inches is light olive brown loam.

The Svea soils are moderately well drained and are level to gently sloping. They are on foot slopes and swales. Typically, the surface soil is black loam about 18 inches thick. The subsoil is loam about 25 inches thick. It is very dark gray in the upper part and light yellowish brown in the lower part. The substratum extends to a depth of 60 inches or more. It is light olive brown loam and is mottled from a depth of 48 inches to a depth of 60 inches.

Hamerly, Buse, Tonka, and Vallers soils are the minor soils in this association. The Hamerly soils are on toe slopes. They are somewhat poorly drained and have a layer of accumulated lime within a depth of 16 inches. The Buse soils are well drained and are on knobs and knolls. Their surface layer and substratum are loam. The Tonka soils are in shallow depressions. They are poorly drained and have a light colored subsurface layer and a subsoil of accumulated clay. The Vallers soils surround depressions. They are poorly drained and have a layer of accumulated lime within a depth of 16 inches.

The soils in this association are used mainly for cultivated crops. They are suited to small grains and sunflowers and to use as pasture. Water erosion, soil blowing, and the wetness of the Tonka and Vallers soils are major concerns in management.

The moderately slow permeability of the soils limits their use for septic tank absorption fields. Slope and shrink-swell potential commonly restrict the use of these soils for building site development.

3. Hamerly-Tonka-Wyard Association

Deep, level to gently sloping, somewhat poorly drained and poorly drained, medium textured soils

The soils that make up this association formed in glacial till and in local alluvium. They are on toe slopes, foot slopes, and in depressions of glacial till plains. These soils are mainly level and nearly level. Some gently sloping soils are adjacent to low ridges.

This association makes up about 15 percent of the county. It is about 32 percent Hamerly soils, 15 percent Tonka soils, 13 percent Wyard soils, and 40 percent soils of minor extent.

The Hamerly soils are somewhat poorly drained and are level to gently sloping. They are on toe slopes. Typically, the surface layer is black loam about 10 inches thick. The subsoil is grayish brown loam about 14 inches thick. The substratum, which extends to a depth of 60 inches or more, is loam. It is olive in the upper part and mottled light olive brown in the lower part.

The Tonka soils are poorly drained and are in depressions. Typically, the surface layer is black loam or silt loam about 7 inches thick. The subsurface layer is loam about 8 inches thick. It is very dark gray in the upper part and mottled grayish brown in the lower part. The subsoil, which is about 25 inches thick, is mottled very dark grayish brown silty clay loam in the upper part and mottled dark grayish brown clay loam in the lower part. The substratum is mottled grayish brown to a depth of 60 inches or more. It is clay loam in the upper part and loam in the lower part.

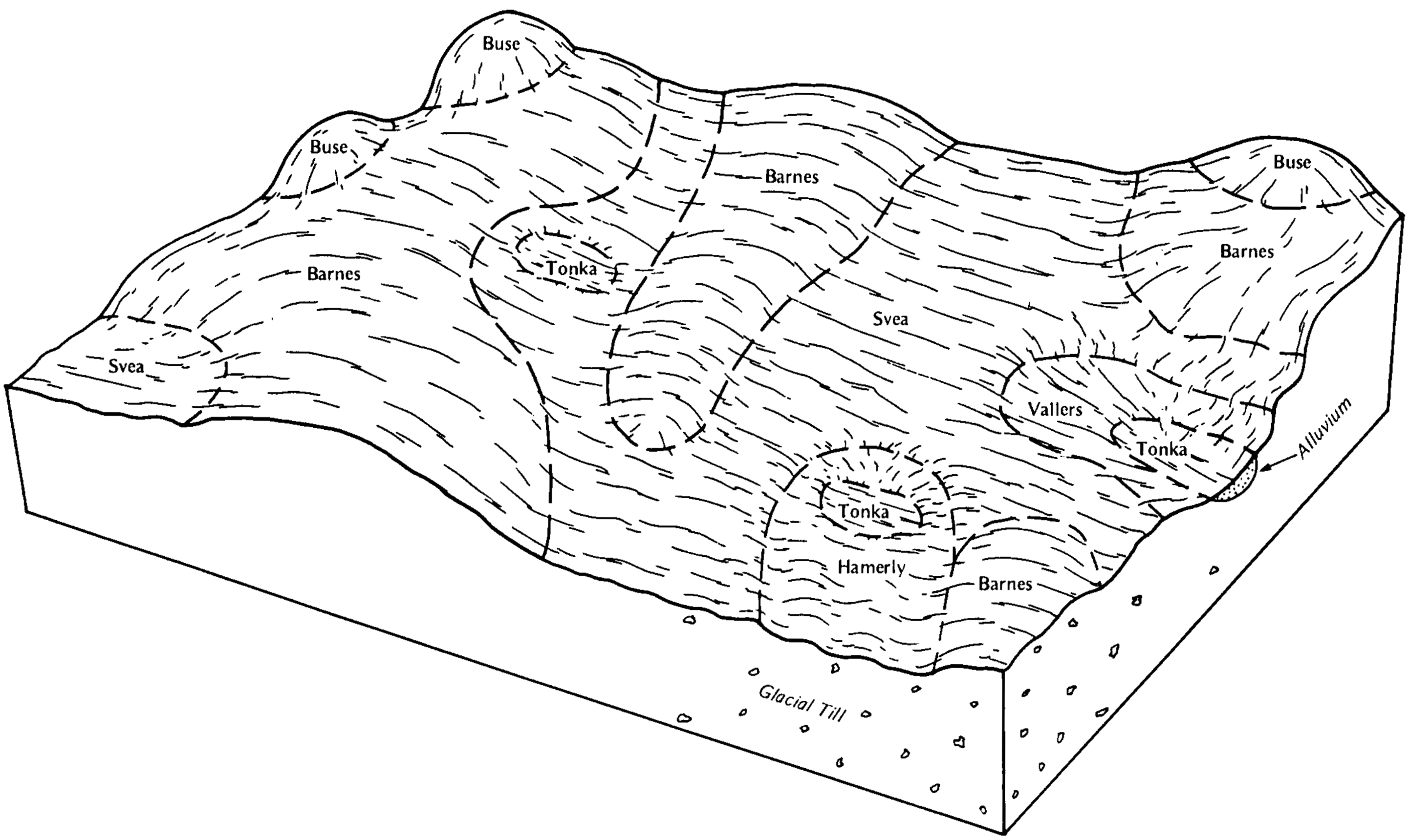

Figure 2.—Typical pattern of soils and underlying material in the Barnes-Svea association.

The Wyard soils are somewhat poorly drained and are nearly level. They are on toe slopes. Typically, the surface layer is black loam about 10 inches thick, and the subsoil is mottled loam about 18 inches thick. The subsoil is very dark grayish brown in the upper part and light brownish gray in the lower part. The substratum, which extends to a depth of 60 inches or more, is mottled loam. It is pale olive in the upper part and olive brown in the lower part.

Barnes, Svea, Vallers, Buse, and Parnell soils are of minor extent in this association. The Barnes soils are well drained and are on side slopes and low knolls. They have a very dark grayish brown subsoil. The Svea soils are moderately well drained. They are on foot slopes in higher positions on the landscape than the Wyard soils. The Svea soils are dark in color to a depth of 16 inches or more. The Vallers soils are poorly drained. They are in positions on the landscape between Hamerly and Tonka soils. The lower part of their substratum is olive gray. The Buse soils are well drained and are on knobs and knolls above the Barnes soils. The Parnell soils are very poorly drained and are in deep depressions. They have a silty clay loam surface layer and are dark in color to a depth of 24 inches or more.

The soils in this association are used mainly for cultivated crops. These soils are suited to small grains and sunflowers. The main concerns in management are soil blowing and wetness where the soils are not drained. If the soils are drained, maintenance of the drainage system is an added concern.

The major soils in this association are limited for use as septic tank absorption fields and building site development because of wetness, slow permeability, ponding, and shrink-swell potential.

4. Vallers-Parnell Association

Deep, level, poorly drained and very poorly drained, medium textured and moderately fine textured soils

The soils that make up this association formed in glacial till and in local alluvium. They are on broad flats and in depressions of glacial till plains. The soils are mainly level.

This association makes up about 1 percent of the county. It is about 35 percent Vallers soils, 33 percent Parnell soils, and 32 percent soils of minor extent.

The Vallers soils are poorly drained and are in level areas surrounding depressions. Typically, the surface layer is black loam about 7 inches thick. The next layer, which is about 4 inches thick, is very dark grayish brown and very dark gray loam. The subsoil is dark gray loam about 7 inches thick. The substratum, which is olive gray clay loam, is mottled from a depth of 28 inches to a depth of 60 inches. In some places the surface layer is silt loam or silty clay loam.

The Parnell soils are very poorly drained and are in deep depressions. Typically, the surface soil is about 18 inches thick. It is black silty clay loam in the upper part and very dark gray silt loam in the lower part. The subsoil is mottled silty clay loam about 22 inches thick. It is very dark brown in the upper part and very dark grayish brown in the lower part. The substratum, to a depth of 60 inches or more, is mottled grayish brown loam. Excess water from spring runoff and from heavy rains commonly ponds in the center of the depressions except in dry years. The edges of the depressions, however, generally are ponded only during part of the growing season.

Hamerly, Wyard, Tonka, and Colvin soils are of minor extent in this association. The Hamerly soils are somewhat poorly drained and are on foot slopes above Vallers and Parnell soils. The lower part of their substratum is light olive brown. The Wyard soils are somewhat poorly drained. They are on toe slopes above the Vallers and Parnell soils. The Tonka soils are in small shallow depressions. They are poorly drained and have a light colored subsurface layer. The Colvin soils are poorly drained and are on broad flats and in swales. They have less sand and more silt than the Vallers soils and have less clay than the Parnell soils.

Some of these soils are used as habitat for wetland wildlife, and some are used for cultivated crops. Undrained soils are suited to habitat for wetland wildlife, and drained soils and the soils in the higher positions on the landscape are suited to cultivated crops. Outlets for drainage are difficult to locate. Wetness, salinity, and soil blowing are the main concerns in management.

Ponding, wetness, slow permeability, and shrink-swell potential commonly restrict the use of the major soils in this association for building site development and septic tank absorption fields.

Level and nearly level, fine textured soils that formed in glacial lacustrine sediment; on glacial lake plains

These soils formed in silty clay lacustrine sediment. They make up about 34 percent of the county. In most areas, water flows to streams in constructed drains. A few depressions and narrow stream valleys are evident.

5. Fargo-Hegne Association

Deep, level and nearly level, poorly drained, fine textured soils

The soils that make up this association formed in glacial lacustrine sediment. They are in swales and on low swells of glacial lake plains. The soils are mainly level and nearly level. In some places, small depressions are common.

This association makes up about 31 percent of the county. It is about 72 percent Fargo soils, 17 percent Hegne soils, and 11 percent soils of minor extent (fig. 3).

The Fargo soils are level and nearly level and are in swales. Typically, the surface layer is black silty clay about 10 inches thick. The subsoil is silty clay about 12 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The next layer, to a depth of 30 inches, is dark grayish brown silty clay. The substratum is olive gray silty clay. It is mottled from a depth of 45 inches to a depth of 60 inches.

The Hegne soils are level and are on low swells. Typically, the surface layer is black silty clay about 7 inches thick. The subsoil is dark gray silty clay about 24 inches thick. The substratum, which extends to a depth of 60 inches or more, is olive gray silty clay. It is mottled from a depth of 46 inches to a depth of 60 inches. In some places the surface layer is silty clay loam.

Dovray, Cashel, Enloe, Wahpeton, and Ryan soils are the minor soils in this association. The Dovray soils are very poorly drained and are in depressions. They are dark colored to a depth of 24 inches or more. The Cashel and Wahpeton soils are on flood plains. The Cashel soils are somewhat poorly drained, and the Wahpeton soils are moderately well drained. The Enloe soils are in small, shallow depressions and are poorly drained. When dry, they have a light colored subsurface layer. The Ryan soils are poorly drained and are in swales. They have an alkali (sodic) subsoil and substratum.

The soils in this association are used mainly for cultivated crops. These soils are suited to small grains, sunflowers, sugar beets, and soybeans and to use as pasture. Wetness is a concern in management where the soils are not drained; however, most of the soils have been drained. Soil blowing and maintenance of the drainage system are the main concerns in the management of drained soils.

High clay content, slow permeability, wetness, and shrink-swell potential restrict the use of the major soils for building site development and septic tank absorption fields.

6. Fargo-Ryan Association

Deep, level, poorly drained, fine textured soils

The soils that make up this association formed in glacial lacustrine sediment. They are on flats and in

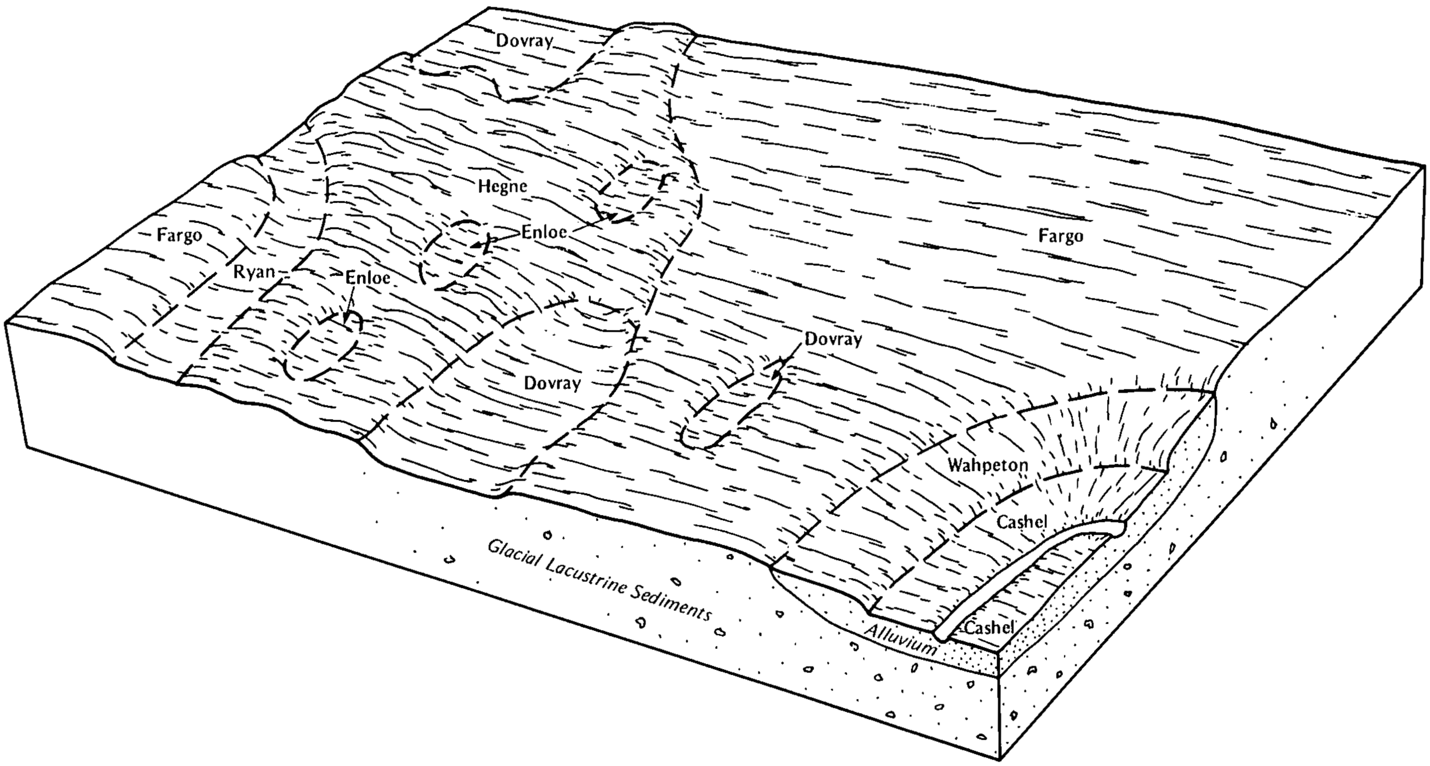

Figure 3.—Typical pattern of soils and underlying material in the Fargo-Hegne association.

swales and slight depressions of glacial lake plains. The soils are mainly level.

This association makes up about 3 percent of the county. It is about 60 percent Fargo soils, 18 percent Ryan soils, and 22 percent soils of minor extent.

The Fargo soils are on flats and in slight swales. Typically, the surface layer is black silty clay about 10 inches thick. The subsoil is silty clay about 12 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The next layer, to a depth of 30 inches, is dark grayish brown silty clay. The substratum, which extends to a depth of 60 inches or more, is olive gray silty clay. It is mottled from a depth of 45 inches to a depth of 60 inches.

The Ryan soils are sodic (alkali). They are in slight depressions. Typically, the surface layer is black silty clay about 4 inches thick. The subsoil is clay about 11 inches thick. It is black in the upper part and dark olive gray in the lower part. The substratum, which extends to a depth of 60 inches or more, is silty clay. It is very dark gray in the upper part and mottled olive gray in the lower part.

Hegne and Dovray soils are of minor extent in this association. The Hegne soils are poorly drained and are on slight swells. They have a layer of accumulated lime within a depth of 16 inches. The Dovray soils are very poorly drained and are in depressions. They are dark colored to a depth of 24 inches or more.

The soils in this association are used mainly for cultivated crops. The soils are suited to small grains and sunflowers and to use as pasture. The main concerns in management are soil blowing and the reduced yields caused by the sodic (alkali) nature of the Ryan soils. Wetness is a concern in management where the soils are not drained. Most of the soils, however, have been drained, and maintenance of the drainage system is an added concern.

Wetness, slow permeability, high clay content, and shrink-swell potential restrict the use of the major soils for septic tank absorption fields and building site development.

Level to gently sloping, moderately fine textured and medium textured soils that formed in glacial lacustrine sediment and in medium textured material over lacustrine sediment; on glacial lake plains

These soils formed in very fine sandy loam, loam, silt loam, silty clay loam, and silty clay lacustrine sediment. They make up about 16 percent of the county. In most

areas water collects in depressions. A few low ridges are evident.

7. Bearden-Colvin Association

Deep, level, somewhat poorly drained and poorly drained, moderately fine textured soils that have a silt loam or silty clay loam substratum

The soils that make up this association formed in glacial lacustrine sediment. They are on swells and in swales of glacial lacustrine plains. The soils are level. In some places, they are saline or sodic.

This association makes up about 1 percent of the county. It is about 35 percent Bearden soils, 32 percent Colvin soils, and 33 percent soils of minor extent.

The Bearden soils are somewhat poorly drained and are on swells. Typically, the surface layer is black silty clay loam about 9 inches thick. The next layer is grayish brown silt loam about 3 inches thick. The subsoil is light olive brown silt loam about 12 inches thick. The substratum, which extends to a depth of 60 inches or more, is light olive brown silt loam in the upper part and grayish brown silty clay loam in the lower part. The substratum is mottled from a depth of 24 inches to a depth of 60 inches. In some places the surface layer is silt loam.

The Colvin soils are poorly drained and are in swales. Typically, the surface layer is black silty clay loam about 8 inches thick. The next layer is dark gray silty clay loam. It is about 5 inches thick. The subsoil is gray silty clay loam in the upper part and mottled light brownish gray silty clay in the lower part. The substratum, which extends to a depth of 60 inches or more, is mottled light brownish gray stratified silt loam and silty clay loam.

Glyndon, Perella, Gardena, and Nahon soils are the minor soils in this association. The Glyndon soils are somewhat poorly drained and are on swells. They have a silt loam surface layer. The Perella soils are in depressions and do not have a layer of accumulated lime within 16 inches of the surface. The Gardena soils are moderately well drained and are on low ridges. They are not mottled above a depth of 25 inches. The Nahon soils are somewhat poorly drained and sodic (alkali). They are in swales.

The soils in this association are used mainly for cultivated crops. The soils are poorly suited to small grains and sunflowers. They are best suited to salt-tolerant crops. The main concerns in management are soil blowing, salinity, and the wetness of the Colvin and Perella soils. On drained soils, maintenance of the drainage system is an added concern.

Wetness, slow permeability, and shrink-swell potential restrict the use of the major soils in this association for septic tank absorption fields and building site development.

8. Bearden-Perella-Overly Association

Deep, level to gently sloping, somewhat poorly drained, poorly drained, and moderately well drained, moderately fine textured soils

The soils that make up this association formed in glacial lacustrine sediment. They are on low ridges and swells and in swales of glacial lake plains. The soils are level to gently sloping. In places, small depressions are common.

This association makes up about 9 percent of the county. It is about 33 percent Bearden soils, 25 percent Perella soils, 11 percent Overly soils, and 31 percent soils of minor extent (fig. 4).

The Bearden soils are level and somewhat poorly drained. They are on swells. Typically, the surface layer is black silty clay loam about 9 inches thick. The next layer is grayish brown silt loam about 3 inches thick. The subsoil is light olive brown silt loam about 12 inches thick. The substratum, which extends to a depth of 60 inches or more, is light olive brown silt loam in the upper part and grayish brown silty clay loam in the lower part. It is mottled between depths of 24 and 60 inches. In some places, the surface layer is silt loam.

The Perella soils are level and are poorly drained or somewhat poorly drained. They are in swales and depressions. Typically, the surface soil is silty clay loam about 18 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is mottled dark grayish brown silty clay loam about 12 inches thick. The substratum, which extends to a depth of 60 inches or more, is mottled olive gray silty clay loam in the upper part and mottled light brownish gray silt loam in the lower part.

The Overly soils are level to gently sloping and are moderately well drained. They are on low ridges. Typically, the surface layer is black silty clay loam about 8 inches thick. The subsoil is silty clay loam about 23 inches thick. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The substratum is light olive brown silty clay loam to a depth of 60 inches or more. It is mottled.

Fargo, Colvin, Hegne, Glyndon, and Dovray soils are of minor extent in this association. The Fargo soils are poorly drained and are in swales. They have a silty clay subsoil and substratum. The Colvin soils also are poorly drained and are in swales. They have a layer of accumulated lime within a depth of 16 inches and a light brownish gray lower substratum. The Hegne soils are poorly drained and are on swells. They have a layer of accumulated lime within a depth of 16 inches. The Glyndon soils are somewhat poorly drained. They are on swells. They have a silt loam surface layer. The Dovray soils are very poorly drained and are in depressions. They have a silty clay surface layer and are dark colored to a depth of 24 inches or more.

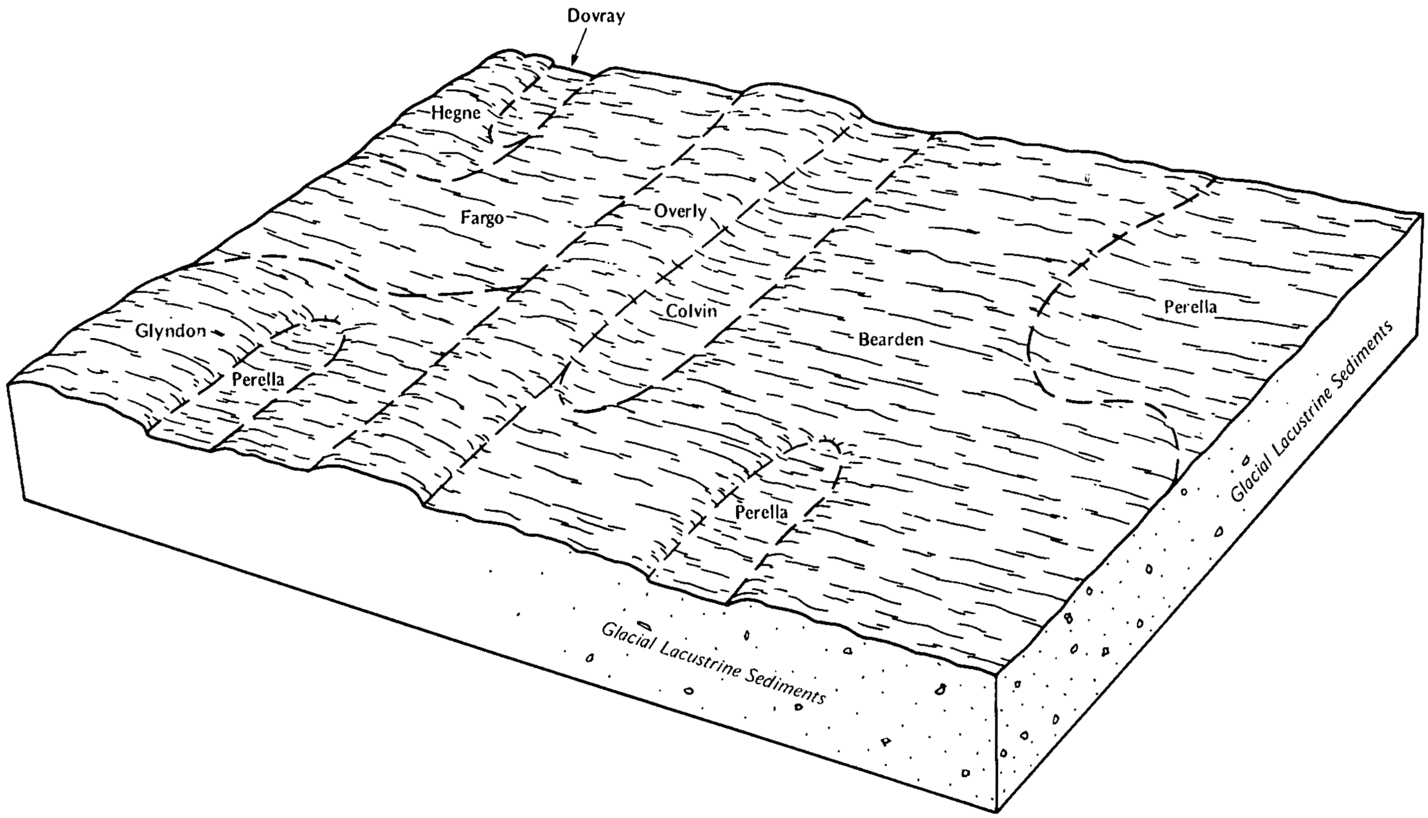

Figure 4.—Typical pattern of soils and underlying material in the Bearden-Perella-Overly association.

The soils in this association are used mainly for cultivated crops. They are well suited to small grains, sunflowers, sugar beets, and soybeans and to use as pasture. Wetness is a concern in management, especially on the poorly drained Perella soils; however, most areas are drained by a system of constructed drains and road ditches. Soil blowing, particularly on the Bearden soils, is a major concern.

Wetness, slow permeability, shrink-swell potential, and ponding restrict the use of the major soils for septic tank absorption fields and building site development.

9. Galchutt-Fargo-Gardena Association

Deep, level and nearly level, moderately well drained, somewhat poorly drained, and poorly drained, moderately fine textured and medium textured soils

The soils that make up this association formed in glacial lacustrine sediment. They are on low ridges and swells and in swales of glacial lake plains. The soils are mainly level and nearly level. Those that are adjacent to low ridges are gently sloping.

This association makes up about 3 percent of the county. It is about 29 percent Galchutt soils, 28 percent Fargo soils, 8 percent Gardena soils, and 35 percent soils of minor extent.

The Galchutt soils are level and are somewhat poorly drained. They are on swells. Typically, the Galchutt soils have a surface soil that extends to a depth of about 17 inches. It is black silty clay loam or silt loam in the upper part and very dark gray loam in the lower part. The subsurface layer is mottled, dark grayish brown very fine sandy loam about 8 inches thick. The subsoil is mottled, olive gray silty clay about 6 inches thick. The substratum to a depth of 60 inches or more is mottled, olive gray silty clay.

The Fargo soils are level and are poorly drained. They are in swales. Typically, the surface layer is black silty clay loam about 10 inches thick. The subsoil is silty clay about 12 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The layer below the subsoil, from a depth of 22 inches to a depth of 30 inches, is dark grayish brown silty clay. The substratum, which extends to a depth of 60 inches or more, is olive gray silty clay. It is mottled at a depth of 45 to a depth of 60 inches. In places the surface layer is silty clay.

The Gardena soils are level and nearly level and are moderately well drained. They are on low ridges and

swells. Typically, the surface soil is black silt loam about 11 inches thick. The subsoil is silt loam about 14 inches thick. It is black in the upper part, very dark grayish brown in the middle part, and grayish brown in the lower part. The substratum, to a depth of 60 inches or more, is mottled silt loam. It is grayish brown in the upper part and light yellowish brown in the lower part.

Aberdeen, Tiffany, Bearden, Hegne, and Glyndon soils are of minor extent in this association. The Aberdeen soils are somewhat poorly drained and are on flats and in swales. They have a sodic (alkali) subsoil. The Tiffany soils are poorly drained and are in swales and depressions. They have a fine sandy loam or very fine sandy loam substratum. The Bearden and Glyndon soils are somewhat poorly drained and are on swells. Within a depth of 16 inches, they have a layer of accumulated lime. The Hegne soils are poorly drained and are on swells. They have a layer of accumulated lime within a depth of 16 inches.

The soils in this association are used mainly for cultivated crops. These soils are well suited to small grains, sunflowers, sugar beets, and soybeans and to use as pasture. Soil blowing and the maintenance of a drainage system are the main concerns in management.

Wetness, slow permeability, and the shrink-swell potential restrict the use of the major soils for building site development and septic tank absorption fields.

10. Hegne-Bearden-Fargo Association

Deep, level, somewhat poorly drained and poorly drained, moderately fine textured soils that have a silt loam, silty clay loam, or silty clay substratum

The soils that make up this association formed in glacial lacustrine sediment. They are on flats and swells and in swales of glacial lake plains. The soils are level. In places, small depressions are common.

This association makes up about 3 percent of the county. It is about 33 percent Hegne soils, 22 percent Bearden soils, 21 percent Fargo soils, and 24 percent soils of minor extent.

The Hegne soils are poorly drained and are on swells. Typically, the surface layer is black silty clay loam about 7 inches thick. The subsoil is dark gray silty clay about 24 inches thick. The substratum, which extends to a depth of 60 inches or more, is olive gray silty clay. It is mottled from a depth of 46 inches to a depth of 60 inches.

The Bearden soils are somewhat poorly drained and are on swells. Typically, the surface layer is black silty clay loam about 9 inches thick. The next layer is grayish brown silt loam about 3 inches thick. The subsoil is light olive brown silt loam about 12 inches thick. The substratum, which extends to a depth of 60 inches or more, is light olive brown silt loam in the upper part and grayish brown silty clay loam in the lower part. It is mottled.

The Fargo soils are poorly drained and are in swales. Typically, the surface layer is black silty clay loam about 10 inches thick. The subsoil is silty clay about 12 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The next layer, to a depth of 30 inches, is dark grayish brown silty clay. The substratum, which extends to a depth of 60 inches or more, is olive gray silty clay. It is mottled from a depth of 45 inches to a depth of 60 inches.

Dovray, Lindaas, Perella, and Overly soils are of minor extent in this association. The Dovray soils are very poorly drained and are in depressions. They are dark colored to a depth of 24 inches or more. The Lindaas soils are poorly drained and are also in depressions. They are dark colored to a depth of 24 inches or more and have a subsoil of accumulated clay. The Perella soils are poorly drained and somewhat poorly drained. They are in depressions and in swales. They do not have a layer of accumulated lime within 16 inches of the surface. The Overly soils are moderately well drained and are on low ridges and swells. They are better drained than Hegne, Bearden, and Fargo soils and do not have mottles within a depth of 31 inches.

The soils in this association are used mainly for cultivated crops. The soils are well suited to small grains, sunflowers, sugar beets, and soybeans and to use as pasture. Soil blowing and maintenance of a drainage system are the main concerns in management. Wetness is a concern on undrained soils. However, most of the soils are drained.

Wetness, slow permeability, and the shrink-swell potential restrict the use of the major soils for building site development and septic tank absorption fields.

Level to gently sloping, medium textured soils that formed in glacial lacustrine sediment; on glacial lake plains

These soils formed in silt loam, loam, very fine sandy loam, and fine sandy loam glacial lacustrine sediment. The soils make up about 11 percent of the county. They are drained mainly by constructed drains and road ditches.

11. Gardena-Glyndon Association

Deep, level and nearly level, somewhat poorly drained and moderately well drained, medium textured soils

The soils that make up this association formed in glacial lacustrine sediment. In places, the soils are underlain by glacial till or fine-textured lake sediment. The soils are on flats, swells, and low ridges of glacial lake plains. The soils are mainly level and nearly level. In places, small depressions are common.

This association makes up about 9 percent of the county. It is about 47 percent Gardena soils, 30 percent Glyndon soils, and 23 percent soils of minor extent.

The Gardena soils are moderately well drained. They are on low ridges and swells. Typically, the surface soil is black silt loam about 11 inches thick. The subsoil is silt loam about 14 inches thick. It is black in the upper part, very dark grayish brown in the middle part, and grayish brown in the lower part. The substratum, which extends to a depth of 60 inches or more, is mottled silt loam. It is grayish brown in the upper part and light yellowish brown in the lower part.

The Glyndon soils are somewhat poorly drained. They are on flats and in swales. Typically, the surface soil is black silt loam about 12 inches thick. The subsoil is mottled silt loam about 16 inches thick. It is dark grayish brown in the upper part and olive brown in the lower part. The substratum, which extends to a depth of 60 inches or more, is light olive brown. It is very fine sandy loam in the upper part and stratified silt loam in the lower part.

Renshaw, Embden, Eckman, Egeland, and Tiffany soils are of minor extent in this association. Renshaw soils are somewhat excessively drained, shallow to sand and gravel, and on side slopes. The Embden soils are moderately well drained. They are on foot slopes and in swales. They have a fine sandy loam surface layer and subsoil. Egeland soils are well drained. They are on side slopes and low knolls. Their surface layer and subsoil are fine sandy loam. Eckman soils are well drained. They are on side slopes and low knolls. Their subsoil is silt loam. Tiffany soils are poorly drained and are in depressions. They are mottled from a depth of 13 inches to a depth of 60 inches.

The soils in this association are used mainly for cultivated crops. These soils are suited to small grains, soybeans, and sunflowers. The main concern in management is soil blowing.

The wetness of the Glyndon soils restricts the use of the major soils for building site development and septic tank absorption fields.

12. Glyndon-Wyndmere-Tiffany Association

Deep, level to gently sloping, somewhat poorly drained and poorly drained, medium textured soils

The soils that make up this association formed in glacial lacustrine sediment. They are on swells and in swales and depressions on glacial lake plains. The soils are level to gently sloping.

This association makes up about 2 percent of the county. It is about 38 percent Glyndon soils, 17 percent Wyndmere soils, 16 percent Tiffany soils, and 29 percent soils of minor extent (fig. 5).

The Glyndon soils are level and nearly level and are somewhat poorly drained. They are on swells. Typically, the surface soil is black silt loam about 12 inches thick. The subsoil is mottled silt loam about 16 inches thick. It is dark grayish brown in the upper part and olive brown in the lower part. The substratum to a depth of 60 inches or more is mottled light olive brown. It is very fine sandy loam in the upper part and stratified silt loam in the lower part.

The Wyndmere soils are level to gently sloping and are somewhat poorly drained. Like the Glyndon soils, they are on swells. Typically, the surface soil is silt loam or loam about 14 inches thick. It is very dark gray in the upper part and very dark grayish brown in the lower part. The subsoil is mottled grayish brown fine sandy loam. The substratum, which extends to a depth of 60 inches or more, is fine sandy loam. It is mottled dark yellowish brown in the upper part and multicolored in the lower part.

The Tiffany soils are level and poorly drained and are in depressions. Typically, the surface soil is black silt loam or loam about 13 inches thick. The next layer is mottled dark grayish brown fine sandy loam about 9 inches thick. The substratum extends to a depth of about 60 inches. It is mottled light olive brown very fine sandy loam in the upper part and mottled light brownish gray silt loam in the lower part.

Gardena, Colvin, Embden, Bearden, and Perella soils are of minor extent in this association. The Gardena soils are on low ridges. They are moderately well drained and are not mottled within a depth of 25 inches. The Colvin soils are poorly drained and are in swales and depressions. They have a silty clay loam surface layer and substratum. The Embden soils are moderately well drained. They are on low ridges. They have a fine sandy loam surface layer and subsoil. The Bearden soils are on swells. They have a silt loam or silty clay loam surface layer and substratum. The Perella soils are poorly drained and somewhat poorly drained. They are in depressions and on swales. They have a silty clay loam surface layer and do not have a layer of accumulated lime within a depth of 16 inches.

The soils in this association are used mainly for cultivated crops. These soils are suited to small grains, sunflowers, and soybeans and to use as pasture. Wetness is a concern in management where the Tiffany soils are not drained. Most of the soils, however, are drained. Soil blowing and maintenance of the drainage system are major concerns.

The wetness and ponding of the Tiffany soils restrict the use of the major soils for building site development and as sites for septic tank absorption fields.

Level to strongly sloping, medium textured, moderately coarse textured, and coarse textured soils that formed in glacial lacustrine sediment, glacial outwash sediment, and alluvium; on glacial lake plains and on glacial outwash plains

The texture of the materials these soils formed in includes silt loam, loam, very fine sandy loam, fine sandy loam, sandy loam, loamy fine sand, and sand. The soils formed in glacial lacustrine, glacial outwash, and alluvium. They make up about 11 percent of the county.

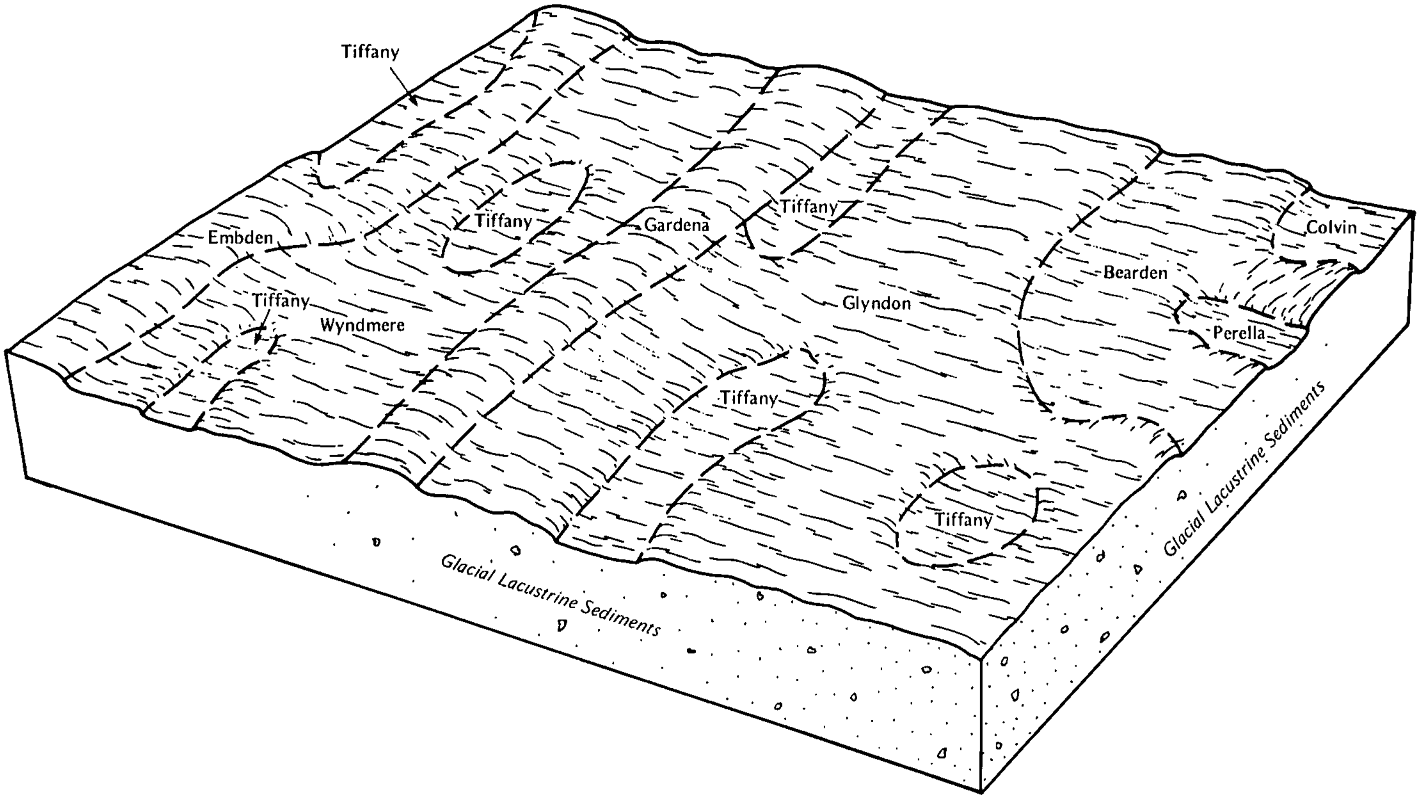

Figure 5.—Typical pattern of soils and underlying material in the Glyndon-Wyndmere-Tiffany association.

In most places, water is drained artificially. A few depressions and narrow stream valleys are evident.

13. Embden-Glyndon-Egeland Association

Deep, level to gently sloping, well drained, moderately well drained, and somewhat poorly drained, moderately coarse textured and medium textured soils

The soils that make up this association formed in glacial lacustrine and outwash sediment. They are on flats, swells, and side slopes and in swales on lake plains and outwash plains. The soils are mainly level and nearly level. Those that are adjacent to low ridges are gently sloping.

This association makes up about 6 percent of the county. It is about 35 percent Embden soils, 34 percent Glyndon soils, 8 percent Egeland soils, and 23 percent soils of minor extent.

The Embden soils are level to gently sloping and are moderately well drained. They are on swells and in broad swales. Typically, the surface soil is black fine sandy loam about 14 inches thick. The subsoil is fine sandy loam about 30 inches thick. It is very dark brown in the upper part, very dark grayish brown in the middle part, and olive brown in the lower part. The subsoil is mottled from a depth of 24 inches to a depth of 44 inches. The substratum is mottled olive brown fine sandy loam to a depth of about 60 inches or more. In some places the lower part of the substratum is sand and gravel.

The Glyndon soils are level and nearly level and are somewhat poorly drained. They are in swales and on flat areas. Typically, the surface soil is black loam about 12 inches thick. The subsoil is mottled silt loam about 16 inches thick. It is dark grayish brown in the upper part and olive brown in the lower part. The substratum to a depth of about 60 inches is mottled light olive brown. It is very fine sandy loam in the upper part and stratified silt loam in the lower part.

The Egeland soils are level to gently sloping and are well drained. They are on swells and side slopes. Typically, the surface layer is black fine sandy loam about 6 inches thick. The subsoil is fine sandy loam about 21 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The substratum extends to a depth of about 60 inches. It is dark brown loamy fine sand in the upper part and yellowish brown fine sand in the lower part.

Gardena, Wyndmere, Eckman, and Galchutt soils are of minor extent in this association. The Gardena soils

are moderately well drained and are on low ridges and broad swells. They have a silt loam surface soil, subsoil, and substratum. The Wyndmere soils are somewhat poorly drained and are on swells. They have a fine sandy loam substratum and a layer of accumulated lime within a depth of 16 inches. The Eckman soils are well drained and are on side slopes. They have a silt loam subsoil. The Galchutt soils are somewhat poorly drained and are on broad flats. They have a silty clay subsoil and substratum.

The soils in this association are used mainly for cultivated crops. The soils are suited to small grains and corn. The main concerns in management are soil blowing, fertility, and the maintenance of drainage systems.

Wetness of the Glyndon soils restricts the use of the major soils for septic tank absorption fields and building site development.

14. Hecla-Hamar-Ulen Association

Deep, level to gently sloping, moderately well drained, somewhat poorly drained, and poorly drained, moderately coarse textured and coarse textured soils

The soils that make up this association formed in glacial lake sediment. They are in depressions and swales and on swells, side slopes, and flats of glacial lake plains. The soils are mainly level or nearly level. Those that are adjacent to low ridges and along drainageways are gently sloping.

This association makes up about 2 percent of the county. It is about 50 percent Hecla soils, 20 percent Hamar soils, 20 percent Ulen soils, and 10 percent soils of minor extent.

The Hecla soils are nearly level and gently sloping and are moderately well drained. They are on broad swells and side slopes. Typically, the surface soil is about 23 inches thick. It is black fine sandy loam in the upper part and very dark brown loamy fine sand in the lower part. The next layer is mottled very dark grayish brown loamy fine sand. The substratum is mottled fine sand to a depth of about 60 inches. It is dark brown in the upper part and dark grayish brown in the lower part. In places the surface layer is loamy fine sand.

The Hamar soils are level and are somewhat poorly drained and poorly drained. They are in swales and depressions. Typically, the surface soil is black loamy fine sand about 30 inches thick. To a depth of about 60 inches, the substratum is grayish brown fine sand. It is mottled from a depth of 20 inches to a depth of 60 inches.

The Ulen soils are level and are somewhat poorly drained and moderately well drained. They are on flats. Typically, the surface layer is black fine sandy loam about 6 inches thick. The subsoil is fine sandy loam about 20 inches thick. It is very dark gray in the upper part and dark grayish brown in the lower part. The substratum is light olive brown to a depth of 60 inches or more. It is loamy fine sand in the upper part, loam in the middle part, and stratified sandy loam and silt loam in the lower part. It is mottled from a depth of 40 inches to a depth of 60 inches.

Embden, Tiffany, and Arveson soils are of minor extent in this association. The Embden soils are moderately well drained and are on low ridges. They have a fine sandy loam surface layer and subsoil. The Tiffany soils are poorly drained and are in depressions. They are mottled from a depth of 13 inches to a depth of 60 inches. The Arveson soils are poorly drained and are in depressions. They have a layer of accumulated lime within a depth of 16 inches.

The soils in this association are used mainly for cultivated crops, although some soils are in native grasses and are used as pasture. The soils are suited to small grains and corn and well suited to use as pasture. The major concerns in management are soil blowing, maintaining drainage systems, fertility, and maintaining the vigor of pasture plants.

Wetness and rapid permeability, which can cause contamination of ground water, restrict the use of the major soils for septic tank absorption fields and building site development.

15. Maddock-Hamar Association

Deep, level to strongly sloping, well drained, somewhat poorly drained, and poorly drained coarse textured soils

The soils in this association formed in glacial lacustrine sediment. They are on side slopes and knobs and in swales and depressions of glacial lake plains. The soils are mainly nearly level and gently sloping. Those that are adjacent to blown out areas are hummocky and moderately sloping. Overblown areas are common.

This association makes up about 1 percent of the county. It is about 50 percent Maddock soils, 30 percent Hamar soils, and 20 percent soils of minor extent.

The Maddock soils are nearly level to strongly sloping and are well drained. They are on side slopes and knobs. Typically, the surface layer is very dark brown loamy fine sand about 9 inches thick. The subsoil is dark grayish brown loamy fine sand about 7 inches thick. The substratum extends to a depth of 60 inches or more. It is brown loamy fine sand in the upper part, yellowish brown loamy fine sand in the middle part, and yellowish brown very fine sandy loam in the lower part.

The Hamar soils are level and nearly level and are somewhat poorly drained and poorly drained. They are in swales and depressions. Typically, the surface soil is black loamy fine sand about 30 inches thick. The substratum to a depth of about 60 inches is grayish brown fine sand. It is mottled from a depth of 20 inches to a depth of 60 inches.

Hecla and Ulen soils are of minor extent in this association. The Hecla soils are moderately well drained and are on swells and foot slopes. The Ulen soils are

somewhat poorly drained and are on broad flats and in swales. They have a layer of accumulated lime within a depth of 16 inches.

The soils in this association are used mainly as pasture, but some soils are used for cultivated crops. The Maddock soils are poorly suited to cultivated crops because of the hazard of soil blowing, which is difficult to control. The Hamar soils are suited to crops if the soils are drained and if soil blowing is controlled. The main concerns in management are maintaining the vigor of pasture plants and controlling soil blowing.

Wetness and rapid permeability, which can cause contamination of ground water, restrict the use of the major soils in this association for septic tank absorption fields and building site development.

16. Renshaw-Sioux Association

Deep, nearly level to strongly sloping, somewhat excessively drained and excessively drained, medium textured soils

The soils that make up this association formed in alluvium and glacial outwash. They are in swales and on swells, side slopes, and low ridges on terraces of glacial outwash plains. The soils are nearly level and gently sloping. Those that are near drainageways and streams and adjacent to ridges are sloping and strongly sloping.

This association makes up about 1 percent of the county. It is 45 percent Renshaw soils, 40 percent Sioux soils, and 15 percent soils of minor extent.

The Renshaw soils are nearly level and gently sloping and are somewhat excessively drained. They are on side slopes of ridges and in swales. Typically, the surface layer is black loam about 7 inches thick. The subsoil is dark grayish brown and about 10 inches thick. It is loam in the upper part, sandy loam in the middle part, and gravelly sandy loam in the lower part. The substratum is sand and gravel to a depth of about 60 inches or more.

The Sioux soils are nearly level to strongly sloping and are excessively drained. They are on swells and low ridges. Typically, the surface soil is black loam about 8 inches thick. The substratum is coarse sand and gravel to a depth of about 60 inches or more. It is dark grayish brown in the upper part and brown in the lower part.

Divide, Spottswood, and Fordville soils are of minor extent in this association. The Divide soils are moderately well drained and somewhat poorly drained and are on flats and in swales. They have a layer of accumulated lime within a depth of 16 inches. They are moderately deep over coarse sand and gravel. The Spottswood soils are moderately well drained and are nearly level. They are on foot slopes of ridges and in swales. They have a sandy loam surface soil and are moderately deep over coarse sand and gravel. They do not have a layer of accumulated lime within a depth of 16 inches. The Fordville soils are well drained and are nearly level and gently sloping. They are on side slopes of beach ridges and on flats. They are moderately deep over coarse sand and gravel.

The soils in this association are used mainly for cultivated crops. In some areas, the soils are used as hayland and pasture. The soils are poorly suited to small grains. They are suited to pasture and hay. The Sioux soils generally are not suited to cultivated crops. The main concerns in management are soil blowing, droughtiness, water erosion, and maintaining the vigor of pasture and hay plants.

The most common limitation affecting use of the major soils as septic tank absorption fields is rapid permeability which can cause contamination of ground water.

17. Ulen-Hecla Association

Deep, level and nearly level, somewhat poorly drained and moderately well drained, coarse textured and moderately coarse textured soils

The soils that make up this association formed in lacustrine sediment. They are on swells and flats and in swales on the glacial lake plain. The soils are mainly level and nearly level.

This association makes up about 1 percent of the county. It is about 60 percent Ulen soils, 15 percent Hecla soils, and 25 percent soils of minor extent.

The Ulen soils are level and are moderately well drained and somewhat poorly drained. They are on flats and in swales. Typically, the surface layer is black fine sandy loam about 6 inches thick. The subsoil is fine sandy loam about 20 inches thick. It is very dark gray in the upper part and dark grayish brown in the lower part. The substratum is light olive brown to a depth of 60 inches or more. It is loamy fine sand in the upper part, loam in the middle part, and stratified very fine sandy loam and silt loam in the lower part. It is mottled from a depth of 40 inches to a depth of 60 inches.

The Hecla soils are level and nearly level and are moderately well drained. They are on swells. Typically, the surface soil is loamy fine sand about 23 inches thick. It is black in the upper part and very dark brown in the lower part. The next layer is mottled very dark grayish brown loamy fine sand about 8 inches thick. The substratum, which extends to a depth of 60 inches or more, is mottled fine sand. It is dark brown in the upper part and dark grayish brown in the lower part. In places the surface layer is fine sandy loam.

Hamar, Embden, and Arveson soils are of minor extent in this association. The Hamar soils are somewhat poorly drained and poorly drained. They are in swales and depressions. They are mottled between depths of 20 inches and 60 inches. The Embden soils are moderately well drained and are on swells and foot slopes. They have a fine sandy loam surface layer and subsoil. The Arveson soils are poorly drained and are in depressions. They have a layer of accumulated lime within a depth of 16 inches.

The soils in this association are used mainly for cultivated crops. The soils are suited to small grains and corn. The main concerns in management are soil blowing and the maintenance of drainage systems.

Wetness and rapid permeability, which can cause contamination of the ground water, restrict the use of the major soils for building site development and septic tank absorption fields.

Level to steep, medium textured and moderately fine textured soils that formed in alluvium and in glacial till; on flood plains and glacial till plains

These soils formed in loam glacial till and in fine sandy loam, loam, silt loam, silty clay loam, and clay loam alluvium. They make up about 4 percent of the county. The soils in this group, except Barnes and Buse soils, are subject to flooding from stream overflow.

18. Barnes-Lamoure-Buse Association

Deep, level to steep, well drained and poorly drained, medium textured and moderately fine textured soils

The soils that make up this association formed in glacial till and in alluvium. They are on valley sides, flood plains, and in glacial outwash channels. The soils are gently sloping to steep. Low stream gradients encourage flooding. A high water table is common.

This association makes up about 1 percent of the county. It is about 30 percent Barnes soils, 16 percent Lamoure soils, 14 percent Buse soils, and 40 percent soils of minor extent.

The Barnes soils are well drained and are gently sloping to strongly sloping. They are on side slopes on valley sides. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 7 inches thick. It is very dark grayish brown in the upper part and grayish brown in the lower part. The next layer, to a depth of 22 inches, is light yellowish brown loam. The substratum is light olive brown loam to a depth of 60 inches or more.

The Lamoure soils are level and are poorly drained. They are on flood plains. The surface soil is about 25 inches thick. It is black silty clay loam in the upper part, black silt loam in the middle part, and mottled very dark gray silt loam in the lower part. The substratum, which extends to a depth of 60 inches or more, is mottled grayish brown. It is silt loam in the upper part and stratified loam and silty clay loam in the lower part. In some places the surface layer is silt loam.

The Buse soils are well drained and are moderately sloping to steep. They are on knolls and on the side slopes of valleys. Typically, the surface layer is very dark gray loam about 7 inches thick. The next layer is very dark grayish brown loam about 3 inches thick. The subsoil is grayish brown loam about 9 inches thick. The substratum is light olive brown loam to a depth of 60 inches or more. In places the surface soil is light brownish gray and is eroded.

Svea, Rauville, Colvin, and Sioux soils are of minor extent in this association. The Svea soils are moderately well drained and are on foot slopes and in swales. They are dark in color to a depth of 16 inches or more. The Rauville soils are very poorly drained and are on flood plains and outwash plains. They are frequently flooded. The Colvin soils are poorly drained and are on outwash plains. They have a layer of accumulated lime within a depth of 16 inches. The Sioux soils are excessively drained and are moderately sloping to strongly sloping. They are on knobs on valley sides. The Sioux soils have a gravelly sand substratum within a depth of 10 inches.

The soils in this association are used mainly as pasture, but in some places they are used for cultivated crops. The soils are best suited to pasture and hay. The gently sloping and moderately sloping soils of the valley sides are suited to small grains. The main concerns in management are wetness, flooding, and water erosion and maintaining the vigor of the pasture plants.

The most common limitations affecting the use of the major soils for building site development and septic tank absorption fields are flooding, slope, and wetness.

19. Fairdale-LaPrairie-LaDelle Association

Deep, level and nearly level, moderately well drained, medium textured and moderately fine textured soils

The soils that make up this association formed in alluvium. They are on flood plains that have been dissected into small, irregularly shaped areas by meandering channels that are bordered by woodlands. Some areas are isolated by deep channels and steep escarpments.

This association makes up about 3 percent of the county. It is about 39 percent Fairdale soils, 12 percent LaPrairie soils, 8 percent LaDelle soils, and 41 percent soils of minor extent.

The Fairdale soils generally are adjacent to the stream channels. Typically, the surface layer is very dark brown stratified silt loam about 6 inches thick. The substratum, in sequence to a depth of 60 inches or more, is dark grayish brown silt loam, grayish brown silt loam, dark grayish brown loam, and dark grayish brown fine sandy loam. It is mottled from a depth of 6 inches to a depth of 27 inches.

The LaPrairie soils are on low terraces on flood plains. Typically, the surface layer is black silt loam about 7 inches thick. The subsoil is very dark grayish brown silt loam about 5 inches thick. The substratum, in sequence to a depth of 60 inches or more, is black, very dark brown, very dark grayish brown, and dark brown silt loam.

The LaDelle soils generally are on the outer edge of the flood plain. Typically, the surface soil is black silty clay loam about 14 inches thick. The subsoil is very dark

gray silty clay loam about 19 inches thick. The substratum, which extends to a depth of 60 inches or more, is very dark grayish brown silty clay loam in the upper part, very dark gray silty clay loam in the middle part, and grayish brown stratified loam and clay loam in the lower part.

Fargo, Cashel, Overly, Bearden, and Hegne soils are of minor extent in this association. The Fargo soils are on adjacent glacial lake plains. They are poorly drained and have a silty clay or silty clay loam surface layer and a silty clay subsoil. The Cashel soils are in low areas on the flood plain. They are somewhat poorly drained and have a silty clay surface layer and substratum. The Overly soils are on adjacent glacial lake plains. They are moderately well drained and have a silty clay loam surface layer, subsoil, and substratum. The Bearden soils are on adjacent glacial lake plains. They are somewhat poorly drained. They have a layer of accumulated lime within a depth of about 16 inches. The Hegne soils are on adjacent lake plains. They are poorly drained and have a silty clay surface layer and substratum. They have a layer of accumulated lime within a depth of 16 inches.

The soils in this association are used mainly for cultivated crops; however, a large part of the native woodland in the county is on these soils. These soils are suited to small grains and sunflowers and to use as pasture. Flooding, deposition or scouring during flooding, and erosion are the main concerns in management. Stream overflow is most common following snowmelt and before the growing season.

Flooding restricts the use of the major soils in this association for building site development and septic tank absorption fields.

Broad Land Use Considerations

In 1980, more than 90 percent of the land in the Cass County survey area was used for cultivated crops *(11)*. The rest was used for pasture and hay, as recreation areas, as wildlife habitat, and for urban development.

The Fargo metropolitan area increased sevenfold in the period 1935 to 1980. About 60 percent of the new growth encroached on prime farmland *(9)*.

The general soil map in this soil survey is useful to those who make broad land use decisions in Cass County.

The soils in the Cass County Area generally are suited to cultivated crops. Salinity is a severe limitation, however, if soils in the Bearden-Colvin association are cultivated. Flooding is a hazard on the soils in the Fairdale-LaPrairie-LaDelle and Barnes-Lamoure-Buse associations. Wetness is a limitation of the soils in the Hamerly-Tonka-Wyard, Vallers-Parnell, Fargo-Hegne, and Fargo-Ryan associations. Many areas have been drained, and maintenance of the drainage systems is a major concern. Soil blowing is a hazard on most soils. It is especially severe on the soils in the Hecla-Hamar-Ulen, Maddock-Hamar, Ulen-Hecla, Hamerly-Tonka-Wyard, Gardena-Glyndon, Glyndon-Wyndmere-Tiffany, Bearden-Colvin, Hegne-Bearden-Fargo, Bearden-Perella-Overly, Embden-Glyndon-Egeland, Fargo-Hegne, and Fargo-Ryan associations. A dense, sodic (alkali) subsoil restricts root penetration in the Ryan soils of the Fargo-Ryan association. The sand and gravel substratum of the soils in the Renshaw-Sioux association limits the moisture holding capacity of the soils. Thus, the soils are droughty for cultivated crops.

Pasture or hay is the second most common land use in the survey area. Most of the soils are well suited to pasture and hay. The soil limitations that affect cropland also affect areas that are used for pasture and hay, but generally to a lesser extent. The soils in the Bearden-Colvin, Maddock-Hamar, Renshaw-Sioux, and Barnes-Lamoure-Buse associations are best suited to pasture and hay.

The distribution of urban land in the Cass County Area generally is not correlated with soil suitability. Some of the soils are poorly suited to urban uses. The soils in the Fairdale-LaPrairie-LaDelle association and those in the Barnes-Lamoure-Buse association, for example, are highly susceptible to stream overflow. The soils in the Fargo-Hegne and Fargo-Ryan associations are subject to surface ponding, especially following snowmelt, and are also subject to overflow from streams. The soils in the Fargo-Hegne association and those in the Fargo-Ryan association are generally not suited to use as septic tank absorption fields because of their high clay content and their slow permeability. The soils in the Hecla-Hamar-Ulen, Maddock-Hamar, Renshaw-Sioux, and Ulen-Hecla associations are poorly suited to use as septic tank absorption fields because of their high permeability and their poor filtering capacity, which can result in ground water pollution.

Wildlife habitat is very limited in Cass County, although the soils generally have good or fair potential for one or more types of wildlife habitat. The soils that are used as wildlife habitat generally are restricted for other uses.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Fargo silty clay loam is one of several phases in the Fargo series.

Some map units are made up of two or more major soils. These map units are called soil complexes, soil associations, or undifferentiated groups.

A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Barnes-Buse loams, 3 to 6 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, gravel, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

1—Fargo-Enloe silty clays. This complex consists of level, deep, poorly drained soils on glacial lake plains. The Fargo soil is in plane and slightly convex, elevated positions and on the edge of swales and shallow depressions. The Enloe soil is in swales and shallow depressions. The natural drainage pattern is poorly defined. Excess surface water is removed in most areas by artificial drainage. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are about 60 percent Fargo soil and 25 percent Enloe soil. The areas range from about 30 to more than 300 acres in size.

Typically, the Fargo soil has a black silty clay surface layer about 10 inches thick. The subsoil is silty clay about 12 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The next layer, which extends to a depth of 30 inches, is dark grayish brown silty clay. The substratum to a depth of 60 inches or more is olive gray silty clay. It is mottled at a depth of 45 inches to a depth of 60 inches. In places the surface layer is silty clay loam. In other places the surface layer is as much as 24 inches thick. In some places the surface layer and subsoil are more than 60 percent clay.

Typically, the Enloe soil has a surface layer of black silty clay about 9 inches thick. The subsurface layer is dark gray silty clay loam about 6 inches thick. The subsoil is clay about 27 inches thick. It is black in the upper part and very dark gray in the lower part. The substratum extends to a depth of 60 inches or more. It is olive gray silty clay in the upper part and pale olive laminated silt and clay in the lower part. It is mottled

between depths of 50 and 60 inches. In some places the surface layer is silty clay loam.

Included with these soils in mapping and making up about 15 percent of the map unit are small areas of Hegne soils. The Hegne soils are in slightly convex, elevated positions and on the edges of swales and in shallow depressions. The soils are calcareous at the surface and have a layer of accumulated lime within a depth of 16 inches.

Fargo and Enloe soils are slowly permeable. Their available water capacity is high. Runoff on the Fargo soil is very slow, and that on the Enloe soil is ponded. The seasonal high water table is at a depth between 0 and 3 feet in the Fargo soil and is 1 foot above the surface or within 1 foot of the surface in the Enloe soil. Because the surface layer is silty clay, tilth generally is poor.

These soils are used mainly for cultivated crops. The soils are well suited to small grains, soybeans, sugar beets, and sunflowers. Wetness and ponding are the main concerns where cultivated crops are grown. Nearly all areas of these soils are drained by parallel field drains and road ditches which require periodic maintenance. Tilling the soil when it is either too wet or too dry can cause soil compaction and poor soil tilth. Returning crop residue to the soil improves soil tilth. Plowing in the fall generally leaves the soil in good condition for seedbed preparation; however, plowing in the fall increases the hazard of soil blowing. Soil blowing is a moderate hazard. It can be controlled by buffer strips and by conservation tillage that leaves crop residue on the surface.

If these soils are drained, they are suited to trees and shrubs used as windbreaks and environmental plantings. Undrained areas generally are too wet. Soil blowing should be controlled to help prevent the damage to seedlings.

These soils are poorly suited to use as building sites. They are generally not suited to use as septic tank absorption fields because of the high clay content, ponding, and slow permeability. Alternate systems of waste disposal, such as a holding tank or a mound system, should be considered. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements. Ponding is a hazard on building sites, but it commonly is overcome by constructing dikes or mounds elevated above the water level.

The land capability classification is IIw.

2—Tonka silt loam. This is a level, deep, poorly drained soil in basins and shallow depressions on glacial till plains. Excess water from spring runoff and from heavy rains frequently ponds on this soil for short periods. The areas of this soil range from about 3 acres to 20 acres in size.

Typically, the surface layer is black silt loam about 7 inches thick. The subsurface layer is loam about 8 inches thick. It is very dark gray in the upper part and mottled grayish brown in the lower part. The subsoil is about 25 inches thick. It is mottled very dark grayish brown silty clay loam in the upper part and mottled dark grayish brown clay loam in the lower part. The substratum to a depth of 60 inches or more is mottled grayish brown. It is clay loam in the upper part and loam in the lower part. In some areas, generally the deeper part of the depressions, there is no subsurface layer or it is thinner than is typical.

Included with this soil in mapping and making up 10 to 25 percent of the map unit are areas of Hamerly, Parnell, and Vallers soils. Hamerly and Vallers soils are in higher positions that surround the depressions and have a layer of accumulated lime within a depth of 16 inches. The Hamerly soils are somewhat poorly drained, and the Vallers soils are poorly drained. The Parnell soils are in the deepest part of the depressions and are very poorly drained. They have a silty clay loam surface layer.

The Tonka soil is slowly permeable. The available water capacity is high. Runoff is ponded. A seasonal high water table fluctuates between 6 inches above the surface and 12 inches below the surface. The surface layer is easily tilled within a wide range in moisture content.

The soil is used mainly for cultivated crops. It is suited to small grains and sunflowers. In most years it is best suited to late seeded crops. Wetness and ponding are the main concerns if cultivated crops are grown. The ponding limits crop growth and is a hazard to harvesting operations in some years. Artificial drainage increases the suitability of the soils for crops, but outlets for surface drains generally are difficult to locate. Soil blowing is a hazard in cultivated areas, particularly those that are plowed in the fall. Field windbreaks, stripcropping, buffer strips, and conservation tillage that leaves crop residue on the surface help reduce soil blowing.

If drained, this soil is suited to trees and shrubs in windbreaks and used as environmental plantings. If not drained, generally it is too wet for trees and shrubs.

This soil generally is not suitable for septic tank absorption fields or for building site development because of ponding, slow permeability, and wetness. The soil generally is not used for these purposes in the survey area. Soils that are suited to these uses generally are nearby.

The land capability classification of this soil is IIw.

3—Parnell silty clay loam. This is a level, deep, very poorly drained soil in deep depressions on glacial till plains. Excess water from spring runoff and from heavy

rains ponds on this soil for long periods. The areas of this soil range from 5 acres to about 40 acres in size.

Typically, the surface soil is about 18 inches thick. It is black silty clay loam in the upper part and very dark gray silt loam in the lower part. The subsoil is mottled silty clay loam about 22 inches thick. It is very dark brown in the upper part and very dark grayish brown in the lower part. The substratum, which extends to a depth of 60 inches or more, is mottled grayish brown loam. In some areas, generally shallow depressions, there is a light colored, mottled subsurface layer. In some areas, generally the deeper depressions, the surface is continuously ponded.

Included with this soil in mapping and making up 5 to 15 percent of the map unit are small areas of Hamerly soils and saline and nonsaline Vallers soils. The included soils have a layer of accumulated lime within a depth of 16 inches. The soils are in higher positions surrounding the depressions.

The Parnell soil is slowly permeable. Its available water capacity is high. Runoff is ponded. A seasonal high water table fluctuates between 2 feet above the surface and 2 feet below the surface.

This soil is used mostly as habitat for wetland wildlife or as hayland. This soil is well suited to use as habitat for wetland wildlife. It is suited to pasture and hay. This soil generally is not suited to cultivated crops or to trees and shrubs unless it is drained. Excessive soil wetness is the critical limitation for the survival, growth, and vigor of trees and shrubs and crops. Outlets for drainage are difficult to locate. Haying is not possible in some years because of the ponding. Deferring grazing, particularly when the soil is wet, helps protect the soil and the vegetation.

This soil generally is not suited to use as septic tank absorption fields and building sites because of ponding, slow permeability, and wetness. In this survey area, this soil generally is not used for these purposes. Suitable soils generally are nearby.

The land capability classification of this soil is IIIw.

4—Perella silty clay loam. This is a level, deep, poorly drained soil in depressions on glacial lake plains. Excess water from spring runoff and from heavy rains frequently ponds on this soil for short periods. The areas of this soil range from 3 to about 80 acres in size.

Typically, the surface soil is silty clay loam about 18 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil, which is about 12 inches thick, is mottled dark grayish brown silty clay loam. The substratum extends to a depth of 60 inches or more. It is mottled olive gray silty clay loam in the upper part and mottled light brownish gray silt loam in the lower part. In some areas, generally shallow depressions, there is a light colored, mottled subsurface layer.

Included with this soil in mapping and making up 15 to 25 percent of the map unit are small areas of Bearden soils and saline and nonsaline Colvin soils. The included soils have a layer of accumulated lime within a depth of 16 inches. They are in higher positions surrounding the depressions.

The Perella soil is moderately slowly permeable. The available water capacity is high. Runoff is ponded. A seasonal high water table fluctuates between 1 foot above the surface and 1 foot below the surface. Because the surface layer is silty clay loam, tilth generally is only fair.

This soil is used mainly for cultivated crops. The soil is suited to small grains, corn, sunflowers, soybeans, and sugar beets. Artificial drainage, which requires yearly maintenance, removes surface water from most areas and increases the suitability of the soil for crops. Wetness is a moderate limitation in undrained areas. Without artificial drainage, wetness can delay or prevent seeding. Soil blowing is a slight hazard. It can be controlled by stripcropping, buffer strips, windbreaks, and conservation tillage that leaves crop residue on the surface. Crop residue and timely cultivation improve soil tilth.

If drained, this soil is suited to trees and shrubs in windbreaks and used as environmental plantings. If not drained, it is generally too wet.

This soil is poorly suited to use as septic tank absorption fields and building sites. Ponding is the major limitation. The seasonal high water table is also a limitation. Surface drains, however, help remove excess surface water. Because of its moderately slow permeability, this soil does not readily absorb effluent in septic tank absorption fields. Enlarging the field helps overcome this limitation. In some areas, a mound system is used for onsite waste disposal. The shrink-swell potential of this soil restricts its use as building sites; but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements.

The land capability classification of this soil is IIw.

5—Dovray silty clay. This is a level, deep, very poorly drained soil in depressions on glacial lake plains. Excess water from spring runoff and from heavy rains frequently ponds on this soil for long periods. The areas of this soil range from 5 to about 80 acres in size.

Typically, the surface soil is black silty clay about 25 inches thick. The subsoil is clay about 32 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The mottled substratum, which extends to a depth of 60 inches or more, is dark gray and olive gray clay. In some areas, the surface soil is 15 to 23 inches thick.

Included with this soil in mapping and making up 5 to 15 percent of the map unit are small areas of Fargo and Hegne soils. The Fargo soils are poorly drained. The Hegne soils have a layer of accumulated lime within a depth of 16 inches. The included soils are in higher lying positions surrounding the depressions.

The Dovray soil is slowly permeable. The available water capacity is high. Runoff is ponded. A seasonal high water table fluctuates between 2 feet above the surface and 1 foot below the surface. Because the surface layer is silty clay, tilth generally is poor.

This soil is used mainly for cultivated crops. The soil is suited to small grains, corn, sunflowers, and soybeans. Wetness generally prevents cultivation in undrained areas; however, artificial drainage removes surface water in most areas, thereby increasing the suitability of the soil for crops. The main concerns in management where the soil is drained and cultivated are poor tilth and poor workability as well as maintenance of the drainage system. Tilling the soil when it is neither too wet nor too dry helps prevent surface compaction and helps improve tilth. Plowing in the fall leaves the soil in good condition for seedbed preparation in the spring, although the practice increases the hazard of soil blowing. Soil blowing is a moderate hazard that can be controlled by buffer strips and conservation tillage that leaves crop residue on the surface.

If drained, this soil is suited to climatically adapted trees and shrubs in windbreaks and environmental plantings. If not drained, generally it is too wet. Measures that control soil blowing help protect seedlings from abrasion.

This soil generally is not suited to use as septic tank absorption fields and building sites because of ponding, slow permeability, and wetness. The soil generally is not used for these purposes in the survey area. Suitable soils generally are nearby.

The land capability classification of this soil is IIIw.

6—Parnell silty clay loam, ponded. This is a level, deep, very poorly drained soil in deep depressions on glacial till plains. Excess water from spring runoff and from heavy rains ponds on this soil except in dry years. The areas of this soil range from 5 acres to about 40 acres in size.

Typically, the surface soil is about 18 inches thick. It is black silty clay loam in the upper part and very dark gray silt loam in the lower part. The subsoil is mottled silty clay loam about 22 inches thick. It is very dark brown in the upper part and very dark grayish brown in the lower part. The substratum, which extends to a depth of 60 inches or more, is mottled, grayish brown loam. In some areas, generally the shallow part of the depressions, the surface is ponded only during part of the growing season.

Included with this soil in mapping and making up 5 to 15 percent of the map unit are small areas of Hamerly soils and saline and nonsaline Vallers soils. These soils have a layer of accumulated lime within a depth of 16 inches. Unlike the Parnell soils, the included soils are in positions that surround the depressions.

The Parnell soil is slowly permeable. The available water capacity is high. Runoff is ponded. A seasonal high water table fluctuates between 2 feet above the surface and 2 feet below the surface.

This soil is used mainly as habitat for wetland wildlife (fig. 6). It is well suited to this use. The soil generally is not suited to hay, pasture, cultivated crops, trees, and shrubs because of wetness. Excessive wetness adversely affects the survival, growth, and vigor of trees and shrubs, crops, and pasture and hay plants. Outlets for drainage are difficult to locate.

This soil generally is not suited to use as septic tank absorption fields and building sites because of ponding, slow permeability, and wetness. The soil generally is not used for these purposes in this survey area. Suitable soils are nearby.

The land capability classification for this soil is Vw.

9C—Nutley-Fargo silty clays, 1 to 9 percent slopes. This complex consists of deep soils on glacial lake plains. The Nutley soil is gently sloping and moderately sloping and is well drained. It is on side slopes of channels. The Fargo soil is nearly level and is poorly drained. It is in slight depressions and on swales. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are about 50 percent Nutley soil and 30 percent Fargo soil. The areas range from about 10 to 100 acres in size.

Typically, the Nutley soil has a black silty clay surface layer about 8 inches thick. The subsoil is silty clay about 30 inches thick. It is dark grayish brown in the upper part and mottled grayish brown in the lower part. The substratum extends to a depth of 60 inches or more. It is mottled grayish brown and has alternating layers of silty clay loam, silty clay, and clay in the lower part.

Typically, the Fargo soil has a black silty clay surface layer about 10 inches thick. The subsoil is silty clay about 12 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The next layer, to a depth of 30 inches, is dark grayish brown silty clay. The substratum extends to a depth of 60 inches or more. It is olive gray silty clay and is mottled between depths of 45 and 60 inches. In places the surface layer is 11 to 24 inches thick.

Included with these soils in mapping and making up about 20 percent of the map unit are small areas of Hegne and Wahpeton soils. The Hegne soils are on swells. They are poorly drained and have a layer of accumulated lime within a depth of 16 inches. The Wahpeton soils are on levees. They are moderately well drained.

Figure 6.—Parnell silty clay loam, ponded, is well suited to use as habitat for wetland wildlife.

The Nutley and Fargo soils are slowly permeable. The available water capacity is high. Runoff is medium on the Nutley soil and slow on the Fargo soil. The Fargo soil has a seasonal high water table at a depth between 0 and 3 feet. Because the surface layer is silty clay, tilth generally is poor.

These soils are used mainly for cultivated crops. The soils are suited to small grains, corn, sunflowers, and soybeans. Controlling soil blowing and water erosion and maintaining or improving tilth are the main concerns where cultivated crops are grown. Soil blowing is a moderate hazard. It can be controlled by stripcropping, buffer strips, windbreaks, and conservation tillage that leaves crop residue on the soil surface. Conservation tillage also helps control water erosion. Timely tillage, when the soil is neither too wet nor too dry, and return of crop residue to the soil improve or maintain soil tilth.

These soils are suited to trees and shrubs in windbreaks and environmental plantings. Measures that control soil blowing help to protect seedlings from abrasion.

These soils are poorly suited to building sites and generally are not suitable for septic tank absorption fields because of the high clay content and slow permeability. An alternate system, such as a mound system, is used in some areas for onsite waste disposal. The shrink-swell potential of these soils restricts their use as building sites. Surface and foundation drains, however, and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements. The Fargo soil is rarely flooded; nevertheless, flooding is a hazard and limits the use of the Fargo soil as a site for buildings. Buildings, however, can be constructed on dikes or mounds that are elevated above the flood plain.

The land capability classification of this complex is IIIe.

10—Fargo-Ryan silty clays. This complex consists of level, deep, poorly drained soils on glacial lake plains. The Fargo soil is in swales. The Ryan soil is sodic and saline and is in slight depressions. The soils are occasionally flooded. The natural drainage pattern is poorly defined; excess surface water is removed in most areas by artificial drainage. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are about 50 percent Fargo soil and 30 percent Ryan soil. The areas range from 10 to 150 acres in size.

Typically, the Fargo soil has a black silty clay surface layer about 10 inches thick. The subsoil is silty clay about 12 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The next layer, which extends to a depth of 30 inches, is dark grayish brown silty clay. The substratum to a depth of 60 inches or more is olive gray silty clay. It is mottled at a depth of 45 inches to 60 inches. In places the surface layer is silty clay loam. In other places the surface layer is 11 to 24 inches thick. In some places the surface layer and subsoil are more than 60 percent clay.

Typically, the Ryan soil has a black silty clay surface layer about 4 inches thick. The subsoil is clay about 11 inches thick. It is black in the upper part and dark olive gray in the lower part. The substratum to a depth of 60 inches or more is silty clay. It is very dark gray in the upper part and mottled olive gray in the lower part.

Included with these soils in mapping and making up about 20 percent of the map unit are small areas of Dovray and Hegne soils. The Dovray soils are in depressions and narrow drainageways. They are very poorly drained and have a surface soil that is 24 inches or more thick. The Hegne soils are on swells. They are poorly drained and have a layer of accumulated lime within a depth of 16 inches.

The Fargo soil is slowly permeable, and the Ryan soil is very slowly permeable. The available water capacity is high. Runoff is very slow. The Fargo soil has a seasonal high water table at a depth of 0 to 3 feet, and the Ryan soil has a water table at a depth of 0 to 1 foot. Because the surface layer is silty clay, tilth generally is poor. The dense subsoil of the Ryan soil restricts penetration of plant roots.

These soils are used mainly for cultivated crops. They are suited to small grains, soybeans, sugar beets, sunflowers, and alfalfa. Artificial drains remove surface water in most areas and thus increase the suitability of the soils for crops. Yearly maintenance is required to keep the drains open. In undrained areas, wetness is a moderate limitation. Tilling the soil when it is either too wet or too dry can cause soil compaction and poor tilth. Returning crop residue to the soil helps maintain or improve tilth. Plowing in the fall generally leaves the soil in good condition for seedbed preparation; however, plowing in the fall increases the hazard of soil blowing. Soil blowing is a moderate hazard. It can be controlled by buffer strips and conservation tillage that leaves crop residue on the surface. Crops grown on these soils have a spotty and uneven appearance because of the dense subsoil and the salt content of the Ryan soil.

The Fargo soil is suited to the trees and shrubs used as windbreaks and environmental plantings. Although it is possible to establish plantings on the Ryan soil, the plants are less likely to survive or grow well. Measures that control soil blowing help prevent damage to seedlings.

These soils are poorly suited to use as building sites. They are generally not suited to use as septic tank absorption fields because of the high clay content, flooding, and slow permeability. Alternate systems of waste disposal, such as a holding tank or a mound system, should be considered. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements. Flooding is a hazard on building sites; however, buildings can be constructed on dikes or mounds that are elevated above the flood plain.

The land capability classification of these soils is IIIs.

11—Nahon silt loam, 0 to 2 percent slopes. This is a level and nearly level, deep, moderately well drained, sodic and saline soil in swales on glacial lake plains. The areas range from 5 to about 40 acres in size.

Typically, the surface layer is black and very dark gray silt loam about 6 inches thick. The subsurface layer is very dark gray silt loam about 2 inches thick. The subsoil is about 26 inches thick. It is black silty clay loam in the upper part, very dark gray silty clay loam in the middle part, and light olive gray silt loam in the lower part. The substratum to a depth of 60 inches or more is light olive brown, mottled silt loam. In some places the surface layer is loam, and in other places material from the subsurface layer extends as narrow tongues into the

subsoil. In a few places there are salts within 16 inches of the surface.

Included with this soil in mapping and making up about 10 to 20 percent of the map unit are small areas of Barnes and Hamerly soils. The Barnes soils have a surface layer and subsoil of loam. The Hamerly soils have a layer of accumulated lime within a depth of 16 inches. The Barnes soils are higher on the landscape than the Nahon soil, and the Hamerly soils are lower.

The Nahon soil is very slowly permeable. The available water capacity is high. Runoff is slow. A seasonal high water table is at a depth of 4 to 6 feet. The surface layer is easily tilled within a wide range in moisture content; however, hard clods form if the soil is tilled when it is too wet. The dense subsoil restricts the penetration of water and plant roots.

This soil is used mainly for cultivated crops. The soil is suited to small grains and sunflowers. Controlling soil blowing and improving infiltration are the main concerns where cultivated crops are grown. Conservation tillage, which leaves crop residue on the surface, helps control soil blowing. Returning crop residue to the soil increases the infiltration rate, improves or maintains soil tilth, and reduces runoff.

This soil is suited to trees and shrubs in windbreaks and trees and shrubs used as environmental plantings; however, survival, growth, and vigor cannot be expected to be optimum. Species should be selected that can tolerate the dense subsoil and high content of sodium.

This soil is poorly suited to use as building sites and septic tank absorption fields. An enlarged absorption field generally is needed to offset the slow absorption of liquid wastes. To offset the seasonal high water table, a mound sewage disposal system or holding tanks could be used in some areas. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced foundation and basement walls help to prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements.

The land capability classification of this soil is IVs.

12—Hegne-Enloe silty clays. This complex consists of level, deep, poorly drained soils on glacial lake plains. The Hegne soil is on swells. The Enloe soil is in swales and shallow depressions. The natural drainage pattern is poorly defined, and excess surface water is removed in most areas by artificial drainage. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are about 45 percent Hegne soil and 35 percent Enloe soil. The areas range from 30 to more than 300 acres in size.

Typically, the Hegne soil has a black silty clay surface layer about 7 inches thick. The subsoil is dark gray silty clay about 24 inches thick. The substratum to a depth of 60 inches or more is olive gray silty clay. It is mottled at a depth of 46 inches to a depth of 60 inches.

Typically, the Enloe soil has a surface layer of black silty clay about 9 inches thick. The subsurface layer is dark gray silty clay loam about 6 inches thick. The subsoil is clay about 27 inches thick. It is black in the upper part and very dark gray in the lower part. The substratum extends to a depth of 60 inches or more. It is olive gray silty clay in the upper part and pale olive laminated silt and clay in the lower part. It is mottled at a depth of 50 inches to a depth of 60 inches. In some places the surface layer is silty clay loam.

Included with these soils in mapping and making up about 20 to 25 percent of the map unit are small areas of Fargo soils. The Fargo soils are in plane and slightly convex elevated positions and on the edge of swales and shallow depressions. The Fargo soils do not have a layer of accumulated lime within a depth of 16 inches.

The Hegne soil is very slowly permeable, and the Enloe soil is slowly permeable. The available water capacity is high. Runoff is very slow on the Hegne soil and ponded on the Enloe soil. A seasonal high water table is at a depth of 1 to 2.5 feet in the Hegne soil. In the Enloe soil the water table is 1 foot above the surface or within 1 foot of the surface. Tilth generally is poor because the surface layer is silty clay.

These soils are used mainly for cultivated crops. The soils are well suited to small grains, soybeans, sugar beets, and sunflowers. Wetness and ponding are the main concerns where cultivated crops are grown. Nearly all areas of these soils are drained by parallel field drains and road ditches. Periodic maintenance is required to keep the drains open. In some drained areas, the soils have increased salinity. Tilling the soil when it is either too wet or too dry can cause soil compaction and poor tilth. Plowing in the fall generally leaves the soil in good condition for seedbed preparation; however, plowing in the fall increases the hazard of soil blowing. Soil blowing is a moderate hazard. It can be controlled by buffer strips and by conservation tillage that leaves crop residue on the surface.

If drained, these soils are suited to trees and shrubs used as windbreaks and environmental plantings. Undrained areas generally are too wet. Measures that control soil blowing help protect seedlings from abrasion.

These soils are poorly suited to use as building sites. They are generally not suited to use as septic tank absorption fields because of the high clay content, ponding, and slow permeability. Alternate systems of waste disposal, such as a holding tank or a mound system, should be considered. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements. Ponding is a hazard on building sites; however, buildings can be constructed on dikes or mounds that are elevated above the water level.

The land capability classification of these soils is IIw.

14B—Barnes-Buse loams, 3 to 6 percent slopes. This complex consists of undulating, deep, well drained soils on glacial till plains. The Barnes soil is on side slopes. The Buse soil is on knolls and ridges. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are 50 to 55 percent Barnes soil and 25 to 40 percent Buse soil. The areas range from about 15 to 160 acres in size.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 7 inches thick. It is very dark grayish brown in the upper part and grayish brown in the lower part. The next layer, to a depth of 22 inches, is light yellowish brown loam. The substratum, which extends to a depth of 60 inches or more, is light olive brown loam. In some places the surface layer is 8 to 16 inches thick. Also, in places the surface layer, subsoil, and substratum are sandy loam or fine sandy loam.

Typically, the Buse soil has a very dark gray loam surface layer about 7 inches thick. The next layer is very dark grayish brown loam about 3 inches thick. The subsoil is grayish brown loam about 9 inches thick. The substratum, which extends to a depth of 60 inches or more, is light olive brown loam. In some places, the surface soil and substratum are sandy loam or fine sandy loam. In places the surface soil is light brownish gray and is eroded.

Included with these soils in mapping and making up 5 to 25 percent of the map unit are small areas of Hamerly and Svea soils. The Svea soils are moderately well drained. They are dark in color to a depth of 16 inches or more. They are on foot slopes. The Hamerly soils are somewhat poorly drained and are on toe slopes. They have a layer of accumulated lime within a depth of 16 inches. The included soils are lower on the landscape than the Barnes soil.

Barnes and Buse soils are moderately slowly permeable. The available water capacity is high. Runoff is medium on the Barnes soil and rapid on the Buse soil. The surface layer is easily tilled throughout a wide range of moisture content.

These soils are used mainly for cultivated crops. They are well suited to small grains, corn, and sunflowers. Where cultivated crops are grown, the main concerns in management are erosion and soil blowing. The latter is a moderate hazard on the Buse soil. Crop residue on the surface, windbreaks, and buffer strips help control soil erosion. Returning crop residue to the soil increases the infiltration rate and reduces runoff.

The Barnes soil is suited to trees and shrubs used in windbreaks and environmental plantings. It is possible to establish plantings on the Buse soil, but optimum growth will not result. Measures that control soil blowing help protect the seedlings from abrasion.

The soils of this complex are suited to septic tank absorption fields and building sites. A larger than average absorption field can help overcome the slow absorption of liquid wastes. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent structural damage caused by shrinking and swelling.

The land capability classification of this complex is IIe.

14C—Barnes-Buse loams, 6 to 9 percent slopes. This complex consists of gently rolling, deep, well drained soils on glacial till plains. The Barnes soil is on side slopes. The Buse soil is on knolls and ridges. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are about 50 to 55 percent Barnes soil and 25 to 40 percent Buse soil. The areas range from 15 to 120 acres in size.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 7 inches thick. It is very dark grayish brown in the upper part and grayish brown in the lower part. The next layer, which extends to 22 inches, is light yellowish brown loam. The substratum is light olive brown loam to a depth of 60 inches or more. In some places the surface layer is 8 to 16 inches thick. Also, in places the surface layer, subsoil, and substratum are sandy loam or fine sandy loam.

Typically, the Buse soil has a very dark gray loam surface layer about 7 inches thick. The next layer is very dark grayish brown loam about 3 inches thick. The subsoil is grayish brown loam about 9 inches thick. The substratum is light olive brown loam to a depth of 60 inches or more. In some places, the surface soil and substratum are sandy loam or fine sandy loam. In places the surface soil is light brownish gray and is eroded.

Included with these soils in mapping and making up about 5 to 25 percent of the map unit are small areas of Hamerly and Svea soils. The Svea soils are moderately well drained and are dark in color to a depth of 16 inches or more. They are on foot slopes. The Hamerly soils are somewhat poorly drained and are on toe slopes. They have a layer of accumulated lime within a depth of 16 inches. The included soils are lower on the landscape than the Barnes soils.

Barnes and Buse soils are moderately slowly permeable. The available water capacity is high. Runoff is medium on the Barnes soil and rapid on the Buse soil. The surface layer is easily tilled throughout a wide range of moisture content.

These soils are used mainly for cultivated crops. They are suited to small grains, corn, and sunflowers. Where cultivated crops are grown, the main concerns in management are erosion and soil blowing. The latter is a moderate hazard on the Buse soil. Conservation tillage that leaves crop residue on the surface, windbreaks, and

buffer strips help control soil erosion. Returning crop residue to the soil increases the infiltration rate and reduces runoff.

The Barnes soil is suited to trees and shrubs used in windbreaks and environmental plantings. It is possible to establish plantings on the Buse soil, but survival and growth will not be optimum. Measures that control soil blowing help protect the seedlings from abrasion.

These soils are suited to septic tank absorption fields and building sites. A larger than average absorption field can help offset the slow absorption of liquid wastes. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling.

The land capability classification of this complex is IIIe.

14D—Barnes-Buse loams, 9 to 15 percent slopes. This complex consists of rolling, deep, well drained soils on glacial till plains. The Barnes soil is on side slopes. The Buse soil is on knolls and ridges. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are about 50 to 55 percent Barnes soil and 25 to 40 percent Buse soil. The areas range from about 15 to 100 acres in size.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 7 inches thick. It is very dark grayish brown in the upper part and grayish brown in the lower part. The next layer, which extends to 22 inches, is light olive brown loam. The substratum is light olive brown loam to a depth of 60 inches or more. In some places the surface layer is 8 to 16 inches thick. Also, in places the surface layer, subsoil, and substratum are sandy loam or fine sandy loam.

Typically, the Buse soil has a very dark gray loam surface layer about 7 inches thick. The next layer is very dark grayish brown loam about 3 inches thick. The subsoil is grayish brown loam about 9 inches thick. The substratum is light olive brown loam to a depth of 60 inches or more. In some places, the surface soil and substratum are sandy loam or fine sandy loam. In places the surface soil is light brownish gray and is eroded.

Included with these soils in mapping and making up about 5 to 25 percent of the map unit are small areas of Hamerly and Svea soils. The Svea soils are moderately well drained and are dark in color to a depth of 16 inches or more. They are on foot slopes. The Hamerly soils are somewhat poorly drained and are on toe slopes. They have a layer of accumulated lime within a depth of 16 inches. The included soils are lower on the landscape than the Barnes soils.

Barnes and Buse soils are moderately slowly permeable. The available water capacity is high. Runoff is rapid on the Barnes soil and very rapid on the Buse soil. The surface layer is easily tilled throughout a wide range of moisture content.

These soils are used mainly for cultivated crops. They are suited to small grains but generally are not suited to row crops. Where cultivated crops are grown, the main concerns in management are erosion and soil blowing. The latter is a moderate hazard on the Buse soil. Conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help control soil erosion. Returning crop residue to the soil increases the infiltration rate and reduces runoff.

The Barnes soil is suited to trees and shrubs used as windbreaks or environmental plantings. It is possible to establish plantings on the Buse soil, but the results will not be ideal. Measures that control soil blowing help protect the seedlings from abrasion.

The soils are suited to septic tank absorption fields and building sites. A larger than average absorption field helps offset the slow absorption of liquid wastes. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Slope is a limitation for building sites and septic tank absorption fields. Buildings and absorption fields should be designed to conform to the natural slope.

The land capability classification of this complex is IVe.

15—Emrick-Heimdal loams, 1 to 3 percent slopes. This complex consists of nearly level, deep, well drained soils on glacial till plains. The Emrick soil is on foot slopes. The Heimdal soil is on side slopes. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are about 50 percent Emrick soil and 30 percent Heimdal soil. The areas range from about 5 to 600 acres in size.

Typically, the Emrick soil has a black loam surface soil about 16 inches thick. The subsoil is loam about 12 inches thick. It is very dark grayish brown in the upper part and light olive brown in the lower part. The substratum to a depth of 60 inches or more is mottled light olive brown loam.

Typically, the Heimdal soil has a black loam surface layer about 6 inches thick. The subsoil is loam about 26 inches thick. It is very dark grayish brown in the upper part, dark brown in the middle part, and light olive brown in the lower part. The substratum is light olive brown to a depth of 60 inches or more. It is loam in the upper part and stratified fine sand in the lower part. In some places the substratum has thin strata of silt and pebbles. Also, in places the surface layer is 8 to 16 inches thick.

Included with these soils in mapping and making up about 20 percent of the map unit are small areas of Esmond, Maddock, and Sioux soils. The Esmond soils are well drained and are on knobs. They have a very

dark gray surface layer. The Maddock soils are well drained and are on ridges and knobs. They have a fine sandy loam surface layer and loamy fine sand subsoil. The Sioux soils are excessively drained and are on ridges. They have an extremely gravelly sand substratum.

Emrick and Heimdal soils are moderately permeable. The available water capacity is high. Runoff is slow on the Emrick soil and medium on the Heimdal soil. The surface layer is easily tilled throughout a wide range of moisture content.

These soils are used mainly for cultivated crops. They are suited to small grains and sunflowers. Soil blowing and water erosion are the main concerns in management where cultivated crops are grown. Field windbreaks, stripcropping, cover crops, and buffer strips help reduce soil blowing. Conservation tillage, which leaves crop residue on the surface, helps control soil blowing and water erosion (fig. 7). Returning crop residue to the soil increases the infiltration rate and reduces runoff.

These soils are suited to trees and shrubs in windbreaks and environmental plantings. No critical limitations affect trees and shrubs.

The soils are suited to septic tank absorption fields and building sites.

The land capability classification of this complex is IIe.

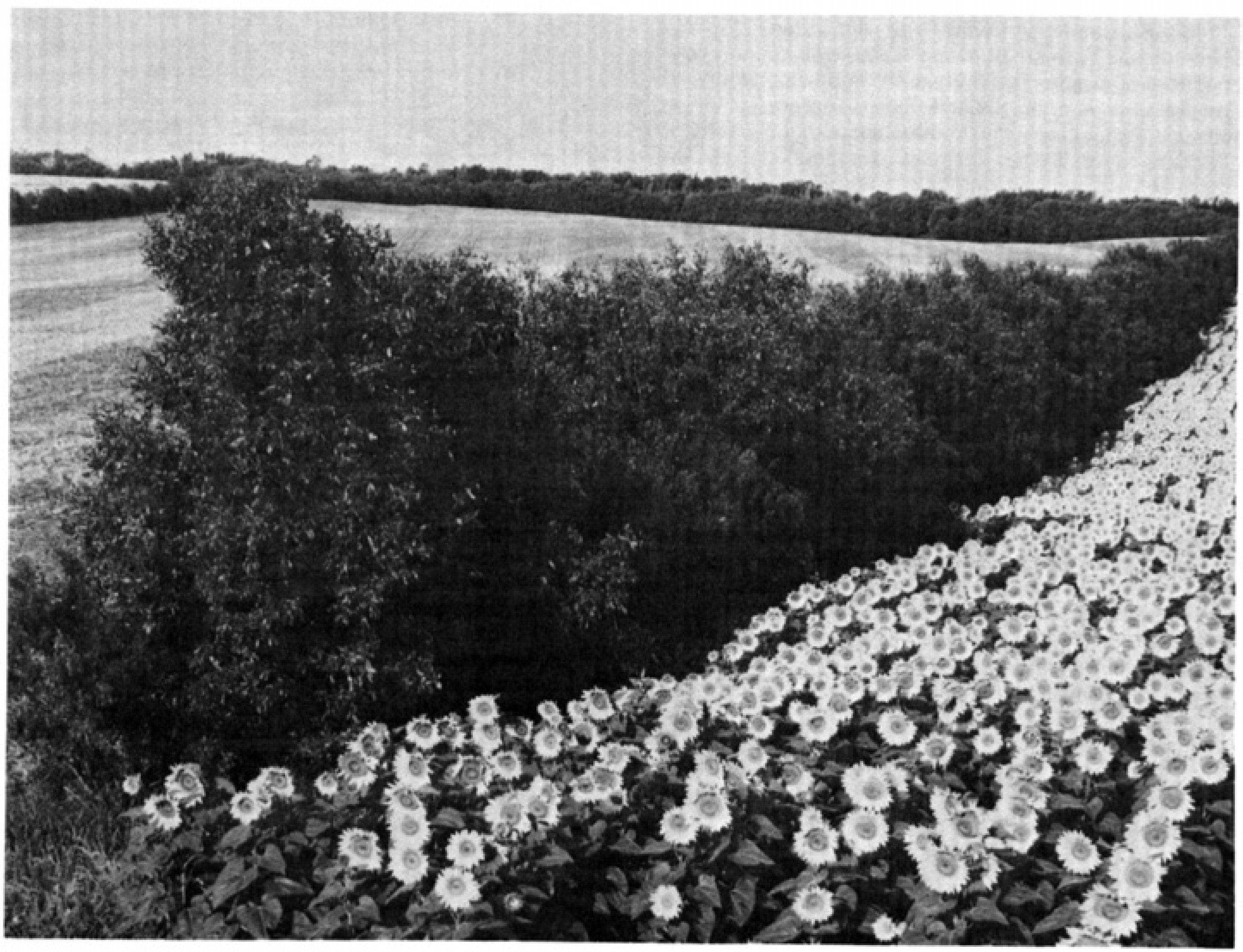

Figure 7.—Windbreaks and small-grain stubble help control erosion on Emrick and Heimdal soils. Sunflowers are grown on about 18 percent of the acreage in the county.

15B—Heimdal-Emrick loams, 3 to 6 percent slopes. This complex consists of gently sloping, deep, well drained soils on glacial till plains. The Heimdal soil is on side slopes and low knolls. The Emrick soil is on foot slopes. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are about 50 to 65 percent Heimdal soil and 30 percent Emrick soil. The areas range from about 5 to 150 acres in size.

Typically, the Heimdal soil has a black loam surface layer about 6 inches thick. The subsoil is loam about 26 inches thick. It is very dark grayish brown in the upper part, dark brown in the middle part, and light olive brown in the lower part. The substratum is light olive brown to a depth of 60 inches or more. It is loam in the upper part and stratified fine sand in the lower part. In some places the surface layer is 8 to 16 inches thick. Also, in places the substratum has strata of silt and pebbles.

Typically, the Emrick soil has a black loam surface soil about 16 inches thick. The subsoil is loam about 12 inches thick. It is very dark grayish brown in the upper part and light olive brown in the lower part. The substratum is mottled light olive brown loam to a depth of 60 inches or more. In some places the surface soil and substratum are sandy loam or fine sandy loam.

Included with these soils in mapping and making up 5 to 20 percent of the map unit are small areas of Esmond, Maddock, and Sioux soils. The Esmond soils are well drained and are on knobs. They have a very dark gray surface layer. The Maddock soils are well drained and are on ridges and knobs. They have a fine sandy loam surface layer and a loamy fine sand subsoil. The Sioux soils are excessively drained and are on ridges. They have an extremely gravelly sand substratum.

Heimdal and Emrick soils are moderately permeable. The available water capacity is high. Runoff is medium on the Heimdal soil and slow on the Emrick soil. The surface layer is easily tilled throughout a wide range of moisture content.

These soils are used mainly for cultivated crops. They are suited to small grains, corn, and sunflowers. Water erosion is the main concern in management where cultivated crops are grown. Conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help control soil erosion. Returning crop residue to the soil increases the infiltration rate and reduces runoff.

These soils are suited to trees and shrubs used as windbreaks or environmental plantings. No critical limitations affect trees and shrubs.

The soils are suited to septic tank absorption fields and building sites.

The land capability classification of this complex is IIe.

15C—Heimdal-Esmond loams, 6 to 9 percent slopes. This complex consists of gently rolling, deep, well drained soils on glacial till plains (fig. 8). The Heimdal soil is on side slopes. The Esmond soil is on knolls and ridges. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are about 50 percent Heimdal soil and 30 percent Esmond soil. The areas range from about 15 to 120 acres in size.

Typically, the Heimdal soil has a black loam surface layer about 6 inches thick. The subsoil is loam about 26 inches thick. It is very dark grayish brown in the upper part, dark brown in the middle part, and light olive brown in the lower part. The substratum to a depth of 60 inches or more is light olive brown. It is loam in the upper part and stratified fine sand in the lower part. In some places the surface layer is 8 to 16 inches thick. Also, in places the substratum has strata of silt and pebbles.

Typically, the Esmond soil has a very dark gray loam surface layer about 6 inches thick. The next layer is grayish brown loam about 6 inches thick. The subsoil is grayish brown fine sandy loam about 12 inches thick. The substratum to a depth of 60 inches or more is olive brown fine sandy loam. In some places the surface soil and substratum are sandy loam or loam. Also, in places the surface soil is light brownish gray and is eroded.

Included with these soils in mapping and making up about 20 percent of the map unit are small areas of Emrick, Maddock, and Sioux soils. The Emrick soils are well drained and are dark in color to a depth of more than 16 inches. They are on foot slopes. The Maddock soils are well drained and have a fine sandy loam surface layer and a loamy fine sand subsoil. They are on ridges and knobs. The Sioux soils are excessively drained and are on ridges. They have an extremely gravelly sand substratum.

Heimdal and Esmond soils are moderately permeable. The available water capacity is high. Runoff is medium on the Heimdal soil and rapid on the Esmond soil. The surface layer is easily tilled throughout a wide range of moisture content.

These soils are used mainly for cultivated crops. They are suited to small grains, corn, and sunflowers. Where cultivated crops are grown, the main concerns in management are erosion and soil blowing. The latter is a moderate hazard on the Esmond soil. Conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help control soil erosion. Returning crop residue to the soil increases the infiltration rate and reduces runoff.

The Heimdal soil is suited to trees and shrubs grown as windbreaks and environmental plantings. It is possible to establish plantings on the Esmond soil, but survival, growth, and vigor will not be optimum. Measures that control soil blowing help to minimize abrasion to seedlings.

The soils are suited to use as septic tank absorption fields and building sites.

The land capability classification of these soils is IIIe.

Figure 8.—Windbreaks help control soil blowing in this area of Heimdal-Esmond loams, 6 to 9 percent slopes. The Esmond soil is on the light colored knolls and ridges. The Heimdal soil is in the darker areas.

15D—Esmond-Heimdal loams, 9 to 15 percent slopes. This complex consists of rolling, deep, well drained soils on glacial till plains. The Esmond soil is on knolls. The Heimdal soil is on side slopes. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are about 50 percent Esmond soil and 30 percent Heimdal soil. The areas range from about 10 to 80 acres in size.

Typically, the Esmond soil has a very dark gray loam surface layer about 6 inches thick. The next layer is grayish brown loam about 6 inches thick. The subsoil is grayish brown fine sandy loam about 12 inches thick. The substratum to a depth of 60 inches or more is olive brown fine sandy loam. In some places the surface soil and substratum are sandy loam or loam. Also, in places the surface is light brownish gray and eroded.

Typically, the Heimdal soil has a black loam surface layer about 6 inches thick. The subsoil is loam about 26 inches thick. It is very dark grayish brown in the upper part, dark brown in the middle part, and light olive brown in the lower part. The substratum to a depth of 60 inches or more is light olive brown. It is loam in the upper part and stratified fine sand in the lower part. In some places the surface layer is 8 to 16 inches thick. Also, in places the substratum has strata of silt and pebbles.

Included with these soils in mapping and making up about 20 percent of the map unit are small areas of Emrick, Maddock, and Sioux soils. The Emrick soils are well drained and are dark in color to a depth of more than 16 inches. They are on foot slopes. The Maddock soils are well drained and have a fine sandy loam surface layer and a loamy fine sand subsoil. They are on ridges and knobs. The Sioux soils are excessively drained and are on ridges. They have an extremely gravelly sand substratum.

Esmond and Heimdal soils are moderately permeable. The available water capacity is high, and runoff is rapid. The surface layer is easily tilled throughout a wide range of moisture content.

These soils are used mainly for cultivated crops, but some are used as pasture. The soils generally are not suited to small grains and row crops. Where cultivated

crops are grown, the main concerns in management are erosion and soil blowing. The latter is a moderate hazard on the Esmond soil. Conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help but do not control erosion adequately. Returning crop residue to the soil increases the infiltration rate and reduces runoff.

These soils are best suited to pasture. Pasture or hayland effectively controls erosion. The key native plants to manage are little bluestem, needleandthread, and western wheatgrass. Overgrazing promotes growth of the less desirable plants and increases the risk of soil erosion. A system of grazing—alternate or deferred—that leaves about 50 percent of the annual growth of the key plants on the soil helps prevent erosion and helps maintain or improve the range.

The Heimdal soil is suited to the trees and shrubs used as windbreaks or environmental plantings. It is possible to establish plantings on the Esmond soil, but the survival rate of the plants will not be optimum. Measures that control soil erosion help reduce the mortality rate of seedlings.

The soils are suited to use as septic tank absorption fields and building sites. Slope, however, is a limitation. Buildings and absorption fields should be designed to conform to the natural slope.

The land capability classification of these soils is VIe.

16B—Barnes-Sioux loams, 3 to 6 percent slopes. This complex consists of undulating, deep soils on glacial till plains and moraines. The Barnes soil is well drained and is on side slopes. The Sioux soil is excessively drained and is on knobs and ridges. It is very shallow over sand and gravel. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are 45 to 55 percent Barnes soil and 30 to 40 percent Sioux soil. The areas range from about 10 to 60 acres in size.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 7 inches thick. It is very dark grayish brown in the upper part and grayish brown in the lower part. The next layer, which extends to a depth of 22 inches, is light yellowish brown loam. The substratum is light olive brown loam to a depth of 60 inches or more. In some places the surface layer is 8 to 16 inches thick. Also, in places the surface layer, subsoil, and substratum are sandy loam or fine sandy loam.

Typically, the Sioux soil has a black loam surface layer about 7 inches thick. The next layer is brown gravelly loamy sand about 4 inches thick. The substratum to a depth of 60 inches or more is grayish brown and brown extremely gravelly sand. In some places the soil is loam or fine sandy loam.

Included with these soils in mapping and making up 5 to 25 percent of the map unit are small areas of Svea and Renshaw soils. The Svea soils are moderately well drained and are dark in color to a depth of 16 inches or more. They are on foot slopes. The Renshaw soils are somewhat excessively drained and are on side slopes. Their lower substratum is very gravelly loamy sand.

The Barnes soil is moderately slowly permeable, and the Sioux soil is rapidly permeable. The available water capacity is high for the Barnes soil and very low for the Sioux soil. Runoff is medium on the Barnes soil and slow on the Sioux soil. The surface layer is easily tilled throughout a wide range of moisture content.

These soils are used mainly for cultivated crops. They are suited to small grains, corn, and sunflowers. Where cultivated crops are grown, water erosion and soil blowing are the main concerns in management. Conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help control soil erosion. Returning crop residue to the soil helps improve soil tilth.

The Barnes soil is suited to trees and shrubs used as windbreaks or environmental plantings, but the Sioux soil generally is not suited.

These soils are suited to building sites. The Barnes soil is suited to septic tank absorption fields, but the Sioux soil is poorly suited. A larger than average absorption field helps compensate for the slow absorption of liquid wastes in the Barnes soil. The Sioux soil readily absorbs effluent but does not adequately filter it in septic tank absorption fields. Consequently, ground water can become polluted. The shrink-swell potential of the Barnes soil is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. The sides of basements and other shallow excavations in the Sioux soils should be shored because the soils tend to cave in.

The land capability classification of this complex is IIIe.

16C—Barnes-Sioux loams, 6 to 9 percent slopes. This complex consists of moderately sloping, deep soils on glacial till plains and moraines. The Barnes soil is well drained and is on side slopes. The Sioux soil is excessively drained and is on knobs and ridges. It is very shallow over sand and gravel. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are 45 to 55 percent Barnes soil and 30 to 40 percent Sioux soil. The areas range from about 5 to 40 acres in size.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 7 inches thick. It is very dark grayish brown in the upper part and grayish brown in the lower part. The next layer, which extends to a depth of 22 inches, is light yellowish brown loam. The substratum is light olive brown loam to a depth of 60 inches or more. In some places the surface layer is 8 to 16 inches thick. Also, in places the

surface layer, subsoil, and substratum are sandy loam or fine sandy loam.

Typically, the Sioux soil has a black loam surface layer about 7 inches thick. The next layer is brown gravelly loamy sand about 4 inches thick. The substratum to a depth of 60 inches or more is grayish brown and brown extremely gravelly sand. In some places the soil is loam or fine sandy loam.

Included with these soils in mapping and making up 5 to 25 percent of the map unit are small areas of Svea and Renshaw soils. The Svea soils are moderately well drained and are dark colored to a depth of more than 16 inches. They are on foot slopes. The Renshaw soils are somewhat excessively drained. They are on side slopes. The lower part of their substratum is very gravelly loamy sand.

The Barnes soil is moderately slowly permeable, and the Sioux soil is rapidly permeable. The available water capacity of the Barnes soil is high, and that of the Sioux soil is very low. Runoff is medium on the Barnes soil and slow on the Sioux soil. The surface layer is easily tilled throughout a wide range of moisture content.

These soils are used mainly for cultivated crops. The soils are suited to small grains, corn, and sunflowers. Water erosion and soil blowing are the main concerns where cultivated crops are grown. Conservation tillage that leaves crop residue on the surface, windbreaks, grassed waterways, contour tillage, and buffer strips help to control soil erosion. Returning crop residue to the soil helps increase infiltration and reduce runoff.

The Barnes soil is suited to trees and shrubs used as windbreaks or environmental plantings; the Sioux soil generally is not suited.

These soils are suited to building sites. The Barnes soil is suited to septic tank absorption fields, but the Sioux soil is poorly suited. A larger than average absorption field can compensate for the slow absorption of liquid wastes in the Barnes soil. The Sioux soil readily absorbs effluent but does not adequately filter it in septic tank absorption fields. Consequently, ground water can be polluted. The shrink-swell potential of the Barnes soil is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. The sides of basements and other shallow excavations in the Sioux soil should be shored to prevent cave-in.

The land capability classification of this complex is IVe.

16D—Barnes-Sioux loams, 9 to 15 percent slopes. This complex consists of strongly sloping, deep soils on glacial till plains. The Barnes soil is well drained and is on side slopes. The Sioux soil is excessively drained and is on knobs and ridges. It is very shallow over sand and gravel. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are 45 to 55 percent Barnes soil and 30 to 40 percent Sioux soil. The areas range from about 10 to 50 acres in size.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 7 inches thick. It is very dark grayish brown in the upper part and grayish brown in the lower part. The next layer, which extends to a depth of 22 inches, in light yellowish brown loam. The substratum to a depth of 60 inches or more is light olive brown loam. In some places the surface layer is 8 to 16 inches thick. In other places the surface layer, subsoil, and substratum are sandy loam or fine sandy loam.

Typically, the Sioux soil has a black loam surface layer about 7 inches thick. The next layer is brown gravelly loamy sand about 4 inches thick. The substratum to a depth of 60 inches or more is grayish brown and brown extremely gravelly sand. In places the surface layer is thicker than is typical, and there is a subsoil.

Included with these soils in mapping and making up 5 to 25 percent of the map unit are small areas of Esmond, Renshaw, and Svea soils. Esmond soils are well drained. They do not have a subsoil. They are on knobs. Renshaw soils are somewhat excessively drained. They are on side slopes. They have a subsoil and a very gravelly loamy sand substratum. Svea soils are dark colored to a depth of more than 16 inches. They are on foot slopes.

The Barnes soil is moderately slowly permeable, and the Sioux soil is rapidly permeable. The available water capacity of the Barnes soil is high and that of the Sioux soil is very low. Runoff is rapid on the Barnes soil and slow on the Sioux soil.

These soils are used for pasture or as habitat for wildlife. Some areas are used for cultivated crops. The soils are best suited to use as rangeland or hayland. The soils generally are not suited to cultivated crops because of the droughtiness of the Sioux soil and the steepness of the slopes. Where cultivated, the soils are susceptible to soil blowing and water erosion. Use of the soils for native grass pasture or hay is effective in controlling water erosion and soil blowing. The key native plants to manage are blue grama, needleandthread, western wheatgrass, and green needlegrass. Prolonged overuse of the key plants will decrease production, increase the number of less desirable plants, and increase soil erosion. A system of alternate grazing and deferment that leaves about 50 percent of the annual growth of the key plants helps protect the soil and maintain the key plants.

The Barnes soil is suited to trees and shrubs used in windbreaks and environmental plantings. The Sioux soil generally is not suited because of droughtiness.

The soils are suited to use as building sites. The Barnes soil is suited to septic tank absorption fields, but the Sioux soil is poorly suited. The slow absorption of liquid wastes in the Barnes soil, which is a problem in

septic tank absorption fields, can be overcome by enlarging the absorption field. The Sioux soil readily absorbs effluent in septic tank absorption fields but does not adequately filter it. The poor filtering capacity can result in the pollution of ground water. The shrink-swell potential of the Barnes soil is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. The sides of basements and other shallow excavations in the Sioux soil should be shored to prevent cave-in. Slope is a limitation for building sites and absorption fields. Buildings and absorption fields can be designed to conform to the natural slope.

The land capability classification of these soils is VIe.

17B—Barnes-Svea loams, 2 to 5 percent slopes. This complex consists of nearly level and gently sloping, deep soils on glacial till plains. The Barnes soil is well drained and is on side slopes and low knolls. The Svea soil is moderately well drained and is on foot slopes and in swales. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are 50 to 55 percent Barnes soil and 25 to 40 percent Svea soil. The areas range from about 5 to 150 acres in size.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 7 inches thick. It is very dark grayish brown in the upper part and grayish brown in the lower part. The next layer, which extends to a depth of 22 inches, is light yellowish brown loam. The substratum to a depth of 60 inches or more is light olive brown loam. In some places the surface layer is 8 to 16 inches thick. Also, in places the surface layer, subsoil, and substratum are sandy loam or fine sandy loam.

Typically, the Svea soil has a black loam surface soil about 18 inches thick. The subsoil is loam about 25 inches thick. It is very dark gray in the upper part and light yellowish brown in the lower part. The substratum to a depth of 60 inches or more is light olive brown loam. It is mottled at a depth of 48 inches to a depth of 60 inches. In some places the surface soil and substratum are sandy loam or fine sandy loam. Also, in places the surface soil is light brownish gray and eroded.

Included with these soils in mapping and making up 5 to 25 percent of the map unit are small areas of Hamerly and Tonka soils. The Hamerly soils are somewhat poorly drained and are on toe slopes. They have a layer of accumulated lime within a depth of 16 inches. Also included are soils along the Maple River that have slopes of 6 to 9 percent. The Tonka soils are poorly drained and are in depressions. They have a subsurface layer that is light in color.

The Barnes and Svea soils are moderately slowly permeable. The available water capacity is high. Runoff is medium on the Barnes soil and slow on the Svea soil. The surface layer of both soils is easily tilled throughout a wide range of moisture content. A seasonal high water table fluctuates between depths of 4 and 6 feet in the Svea soil.

These soils are used mainly for cultivated crops. They are well suited to small grains, corn, and sunflowers (fig. 9). Water erosion is the main concern in management where cultivated crops are grown. Conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help to control soil erosion. Returning crop residue to the soil helps increase infiltration and reduces runoff.

The soils are suited to trees and shrubs used as windbreaks or environmental plantings.

The soils are suited to use as septic tank absorption fields and building sites. A larger than average absorption field helps offset the slow absorption of liquid wastes. A seasonal high water table restricts the use of the Svea soil for septic tank absorption fields. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains on the Svea soil help prevent seepage into basements.

The land capability classification of this complex is IIe.

18—Bearden silty clay loam. This is a level, deep, somewhat poorly drained soil on swells on glacial lake plains. The natural drainage pattern is poorly defined. The areas of this soil range from about 20 to 200 acres in size.

Typically, the surface layer is black silty clay loam about 9 inches thick. The next layer is grayish brown silt loam about 3 inches thick. The subsoil is light olive brown silt loam about 12 inches thick. The substratum extends to a depth of 60 inches or more. It is light olive brown silt loam in the upper part and grayish brown silty clay loam in the lower part. It is mottled at a depth of 24 inches to a depth of 60 inches. In places the surface layer is loam or silt loam. Also, in other places the soil contains more sand throughout.

Included with this soil in mapping and making up about 5 to 25 percent of the map unit are small areas of Colvin, Overly, and Perella soils. The Colvin soils are in swales. They are poorly drained and have a light brownish gray substratum. The Overly soils are on slight ridges. They are moderately well drained and have a subsoil of silty clay loam. The Perella soils are in depressions. They are poorly drained and are mottled near the surface.

The Bearden soil is moderately slowly permeable. The available water capacity is high. Runoff is slow. A seasonal high water table fluctuates between depths of 2 and 4 feet. Because the surface layer is silty clay loam, soil tilth generally is only fair.

Figure 9.—An area of Barnes-Svea loams, 2 to 5 percent slopes. Barnes and Svea soils are suited to small grains. Tonka soils are in the dark areas, where ponding in depressions can prevent seeding.

The soil is used mainly for cultivated crops. It is suited to small grains, corn, sunflowers, soybeans, and sugar beets. Artificial drainage removes surface water in most areas, thus increasing the suitability of the soil for crops. Although seeding is sometimes delayed in undrained areas, the common crops are grown each year. Soil blowing is a moderate hazard. It can be controlled by the use of stripcropping, buffer strips, windbreaks, and conservation tillage that leaves crop residue on the surface. Timely cultivation and crop residue help maintain or improve tilth.

The Bearden soil is suited to trees and shrubs used as windbreaks or environmental plantings. Measures that control soil blowing help protect seedlings from abrasion.

This soil is poorly suited to use as septic tank absorption fields. It is suited to use as building sites. The slow absorption of liquid wastes is a problem in septic tank absorption fields, but it can be overcome by enlarging the absorption field. The seasonal high water table, however, is a continuing limitation. An alternate system, such as a mound system, can be used in some areas for onsite waste disposal. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements.

The land capability classification of this soil is IIe.

19—Colvin silty clay loam, saline. This is a level, deep, poorly drained, moderately saline soil on broad flats and in swales on glacial lake plains. This soil is occasionally flooded. The areas of this soil range from about 3 to 60 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. It has white flecks of salt. The next layer is dark gray silty clay loam about 5 inches thick. The subsoil is gray silty clay loam in the upper part and mottled light brownish gray silty clay loam in the lower part. The substratum to a depth of 60 inches or more is mottled light brownish gray stratified silt loam and silty clay loam. In some places the surface layer is silt loam. Also, in places the surface layer has no salts.

Included with this soil in mapping and making up about 15 to 20 percent of the map unit are small areas of saline Bearden and Perella soils. The Bearden soils are somewhat poorly drained and have a light olive brown upper substratum. They are on swells. The Perella soils are dark in color to a depth of 10 inches or more. They have lime below a depth of 18 inches. They are in depressions.

The Colvin soil is moderately slowly permeable. The available water capacity is moderate. Runoff is very slow. A seasonal high water table fluctuates between depths of 0 and 2 feet. Because the surface layer is silty clay loam, hard clods form if the soil is tilled when it is too wet and a crust forms following hard rains.

This soil is used mainly for cultivated crops. It is suited to small grains, row crops, and grasses. Artificial drainage removes excess surface water in most areas. Although drainage increases the suitability of this soil for crops, increased salinity has been observed in some drained soils. Because salinity reduces the water available for plant use and restricts growth, salt-tolerant crops should be planted on this soil. On drained cropland, soil blowing is the main concern in management. Soil blowing is a moderate hazard. It can be controlled by cover crops, buffer strips, and conservation tillage that leaves crop residue on the surface. Timely cultivation and crop residue on the soil help maintain or improve tilth.

This soil is suited to trees and shrubs used as windbreaks or environmental plantings, but only the most salt-tolerant species should be used. Drainage increases suitability for this use, but salinity is a continuing limitation. Seedling survival is poor, and the vigor, density, and height of the surviving trees and shrubs are severely restricted.

This soil is generally not suited to use as building sites or septic tank absorption fields because of flooding. Soils that are better suited to these uses are generally nearby.

The land capability classification of this soil is IIIs.

20—Bearden silty clay loam, saline. This is a level, deep, somewhat poorly drained, moderately saline soil on swells on glacial lake plains. The natural drainage pattern is poorly defined. Individual areas of this soil range from about 10 to 100 acres in size.

Typically, the surface layer is black silty clay loam about 9 inches thick. It contains white flecks of salt. The next layer is grayish brown silt loam about 3 inches thick. The subsoil is light olive brown silt loam about 12 inches thick. The mottled substratum, which extends to a depth of 60 inches or more, is light olive brown silt loam in the upper part and grayish brown silty clay loam in the lower part. In places the surface layer is loam or silt loam. In other places the soil contains more sand throughout.

Included with this soil in mapping and making up about 10 to 25 percent of the map unit are small areas of Overly and Perella soils and of saline and nonsaline Colvin soils. The Overly soils are on slight ridges. They are moderately well drained and have a silty clay loam subsoil. The Perella soils are in depressions. They are poorly drained and have mottles near the surface. The Colvin soils are in swales. They are poorly drained and have a light brownish gray substratum.

The Bearden soil is moderately slowly permeable. The available water capacity is moderate. Runoff is slow. A seasonal high water table fluctuates between depths of 2 and 4 feet. Because the surface layer is silty clay loam, soil tilth generally is only fair.

This soil is used mainly for cultivated crops. The soil is poorly suited to small grains and sunflowers. The high content of salt restricts plant growth. Wetness and soil blowing are other concerns in management where cultivated crops are grown. Adequate outlets for drainage water generally are difficult to locate. Surface drains help reduce wetness. Only salt-tolerant crop species should be used. Summer fallow and deep tillage compound the salinity problem. Increased salinity has been observed in some drained areas. Soil blowing is a moderate hazard. Intensive use of buffer strips and of crop residue on the surface help to reduce soil blowing. Timely cultivation helps maintain or improve soil tilth.

This soil is suited to trees and shrubs used as windbreaks or environmental plantings, but only the most salt-tolerant species should be used. Seedling survival is poor, and the vigor, density, and height of the surviving trees and shrubs are severely restricted.

This soil generally is poorly suited to use as septic tank absorption fields and as building sites because of wetness. An enlarged absorption field generally is needed to offset the slow absorption of liquid wastes. The seasonal high water table is a continuing limitation. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help to prevent the damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements.

The land capability classification of this soil is IIIs.

22—Bearden-Perella silty clay loams. This complex consists of level, deep, somewhat poorly drained soils on glacial lake plains. The Bearden soil is on plane and slightly convex swells, and the Perella soil is in swales and depressions. The natural drainage pattern is poorly defined, and excess surface water is removed in most areas by a system of constructed drains. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are about 55 percent Bearden soil and 40 percent Perella soil. The areas range from about 30 to 600 acres in size.

Typically, the Bearden soil has a black silty clay loam surface layer about 9 inches thick. The next layer is grayish brown silt loam about 3 inches thick. The subsoil is light olive brown silt loam about 12 inches thick. The mottled substratum, which extends to a depth of 60 inches or more, is light olive brown silt loam in the upper part and grayish brown silty clay loam in the lower part. In places the surface layer is loam or silt loam. In other

places the soil contains more sand throughout than is typical.

Typically, the surface soil of the Perella soil is silty clay loam about 16 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is dark grayish brown silty clay loam about 10 inches thick. The substratum, which extends to a depth of 60 inches or more, is mottled olive gray silty clay loam in the upper part and mottled light brownish gray silt loam in the lower part. In places the subsoil has an accumulation of clay. In other places the surface layer is silt loam. In a few places there are lenses of fine sandy loam or loamy sand in the substratum.

Included with these soils in mapping and making up about 5 percent of the map unit are small areas of Colvin and Overly soils. The Colvin soils are in swales. They are poorly drained. The Overly soils are on slight ridges. They are moderately well drained.

Bearden and Perella soils are moderately slowly permeable. The available water capacity is high. Runoff is slow. A seasonal high water table fluctuates between depths of 2 and 4 feet. Because the surface layer is silty clay loam, soil tilth generally is only fair.

These soils are used mainly for cultivated crops. They are suited to small grains, corn, sunflowers, soybeans, and sugar beets. Artificial drainage on the Perella soil removes surface water in most areas and increases the suitability of the soils for crops. The common crops are grown each year in areas that are not drained, but seeding is delayed by wetness. Yearly maintenance is required to keep open the system of drains. Soil blowing is a moderate hazard. It can be controlled by stripcropping, buffer strips, windbreaks, and conservation tillage that leaves crop residue on the surface. Timely cultivation and crop residue help maintain or improve soil tilth.

These soils are suited to trees and shrubs used as windbreaks or environmental plantings. Measures that control soil blowing help protect seedlings from abrasion.

These soils are poorly suited to use as septic tank absorption fields and building sites. An enlarged absorption field generally is needed to offset the slow absorption of liquid wastes. The seasonal high water table is a continuing limitation for septic tank absorption fields. An alternate system of onsite waste disposal, such as a mound system, can be used in some areas. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements.

The land capability classification of these soils is IIe.

23F—Buse-Barnes loams, 15 to 35 percent slopes. This complex consists of hilly and steep, deep, well drained soils on glacial till plains. The Buse soil is hilly and steep. It is on knolls. The Barnes soil is hilly. It is on side slopes. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are about 45 to 55 percent Buse soil and 30 to 40 percent Barnes soil. The areas range from about 10 to 80 acres in size.

Typically, the Buse soil has a very dark gray loam surface layer about 7 inches thick. The next layer is very dark grayish brown loam about 3 inches thick. The subsoil is grayish brown loam about 9 inches thick. The substratum to a depth of 60 inches or more is light olive brown loam. In some places the surface soil and substratum are sandy loam or fine sandy loam. In places the surface is light brownish gray and is eroded.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 7 inches thick. It is very dark grayish brown in the upper part and grayish brown in the lower part. The next layer, which extends to a depth of 22 inches, is light olive brown loam. The substratum to a depth of 60 inches or more is light olive brown loam. In some places the surface layer is 8 to 16 inches thick. In other places the surface layer, subsoil, and substratum are sandy loam or fine sandy loam.

Included with these soils in mapping and making up 5 to 25 percent of the map unit are small areas of Hamerly and Svea soils. The somewhat poorly drained Hamerly soils are on toe slopes. They have a layer of accumulated lime within a depth of 16 inches. The moderately well drained Svea soils are dark colored to a depth of more than 16 inches. They are on foot slopes.

Buse and Barnes soils are moderately slowly permeable. The available water capacity is high. Runoff is very rapid on the Buse soil and rapid on the Barnes soil.

These soils are used mainly as pasture or habitat for wildlife. They are best suited to use as range or pasture. The soils generally are not suited to cultivated crops, trees, or shrubs because erosion is a hazard and the slopes are steep. The use of the soils as pasture or range is effective in controlling soil erosion. The key native plants to manage are little bluestem, needleandthread, and western wheatgrass. Overgrazing promotes the growth of less desirable plants and increases the risk of erosion. Alternate grazing or deferred grazing, which leaves about 50 percent of the annual growth of the key plants, helps protect the soil and helps maintain the range in good condition.

The soils are suited to use as building sites and septic tank absorption fields. An enlarged absorption field generally is needed to offset the slow absorption of liquid wastes. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Slope is a limitation for building sites and absorption

fields, but it can be overcome by designing buildings and absorption fields to conform to the natural slope.

The land capability classification of these soils is VIe.

24—Cashel silty clay. This is a level, deep, somewhat poorly drained soil on floodplains (fig. 10). This soil is occasionally flooded. Individual areas range from 5 to more than 80 acres in size.

Typically, the surface layer is black silty clay about 7 inches thick. The substratum, which extends to a depth of 60 inches or more, is silty clay. The upper part is very dark grayish brown, the middle part is very dark gray, and the lower part is dark gray and gray. In some places the soil is darker colored than is typical to a depth of more than 24 inches, and in a few places it is poorly drained.

Included with this soil in mapping and making up about 15 to 25 percent of the map unit are small areas of Fairdale, Fargo, Hegne, and Wahpeton soils. The Fairdale soils have a silt loam surface layer. Fargo soils are in swales, and Hegne soils are on swells of the adjacent glacial lake plain. Both are poorly drained. The Wahpeton soils are on flood plains and on low stream terraces. They are moderately well drained.

The Cashel soil is moderately slowly permeable. The available water capacity is high. Runoff is slow. A seasonal high water table fluctuates between depths of 1 and 3 feet. Because the surface layer is silty clay, tilth generally is poor.

This soil is used mainly for cultivated crops. In a few wooded areas, it is used as pasture. The soil is suited to small grains, corn, sunflowers, soybeans, and sugar beets. Flooding after spring snowmelt and after heavy summer storms is a concern in management. Spring floods delay seeding in some years. Keeping the soil in good tilth is another concern. Tilling the soil when it is neither too wet nor too dry helps prevent surface compaction and improves tilth. Returning crop residue to

Figure 10.—An area of Cashel silty clay. This soil is subject to flooding, but flooding generally occurs before crops are planted. Fargo and Hegne soils are in the background.

the soil also improves tilth. Plowing in the fall generally leaves the soil in good condition for seedbed preparation in the spring. Fall plowing, however, increases the hazard of soil blowing. Soil blowing is a moderate hazard. Buffer strips and conservation tillage that leaves crop residue on the soil help control soil blowing.

This soil is suited to trees and shrubs used as windbreaks and environmental plantings. Grasses and weeds should be removed before the trees are planted and should be controlled after a windbreak is established.

This soil is suited to use as pasture, and this use is effective in controlling soil erosion. The key native plants to manage are big bluestem, green needlegrass, and western wheatgrass. Overgrazing of the key plants will decrease production, promote the growth of less desirable plants, and increase the risk of soil erosion. Alternate grazing or deferred grazing, which leaves about 50 percent of the annual growth of the key plants, helps protect the soil and helps maintain the pasture in good condition.

This soil generally is not suited to use as building sites or for septic tank absorption fields because of flooding. Better sites that are not subject to flooding are generally nearby.

The land capability classification of this soil is IIe.

25—Cashel silty clay, channeled. This is a level, deep, somewhat poorly drained soil on flood plains. This soil is occasionally flooded, and it is subject to land sliding and slumping. It is fragmented by meandering channels and short steep escarpments. Individual areas range from 5 to more than 80 acres in size.

Typically, the surface layer is black silty clay about 7 inches thick. The substratum extends to a depth of 60 inches or more. It is silty clay. The upper part is very dark grayish brown, the middle part is very dark gray, and the lower part is dark gray and gray. In some places the soil is darker colored than is typical to a depth of more than 24 inches, and in a few places it is poorly drained.

Included with this soil in mapping and making up 15 to 25 percent of the map unit are small areas of Fairdale, Fargo, Hegne, and Wahpeton soils. The Fairdale soils have a silt loam surface layer. Fargo soils are in swales, and Hegne soils are on swells of the adjacent glacial lake plain. The Wahpeton soils are on levees and low stream terraces. They are moderately well drained.

The Cashel soil is moderately slowly permeable. The available water capacity is high. Runoff is slow. A seasonal high water table fluctuates between depths of 1 and 3 feet.

This soil is best suited to use as pasture and as habitat for wildlife. It is generally not suited to cultivated crops because of the rough channeled topography. The use of this soil as pasture is effective in controlling soil erosion. The key plants to manage are big bluestem, green needlegrass, and western wheatgrass. Prolonged overgrazing of the key plants will decrease production, promote the growth of less desirable plants, and increase the risk of erosion. Alternate grazing or deferred grazing, which leaves about 50 percent of the annual growth of the key plants, helps protect the soil and helps maintain the key plants.

This soil is suited to trees and shrubs used as windbreaks and environmental plantings; however, the complex slopes make the use of machinery difficult. Grasses and weeds should be removed before trees are planted and should be controlled after a windbreak is established.

This soil is generally not suited to use as building sites or for septic tank absorption fields because of flooding. Better sites that are not subject to flooding are generally nearby.

The land capability classification of this soil is VIw.

26—Colvin silty clay loam. This is a level, deep, poorly drained soil on broad flats and in swales on glacial lake plains. The natural drainage pattern is poorly defined. Individual areas range from 5 to more than 80 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The next layer is dark gray silty clay loam about 5 inches thick. The subsoil is gray silty clay loam in the upper part and mottled light brownish gray silty clay in the lower part. The substratum to a depth of 60 inches or more is mottled light brownish gray stratified silt loam and silty clay loam. In some places the surface layer is silt loam. In other places the surface layer contains salts.

Included with this soil in mapping and making up about 10 to 20 percent of the map unit are small areas of Bearden and Perella soils. The Bearden soils are somewhat poorly drained and have a light olive brown upper substratum. They are on swells. The Perella soils are dark colored to a depth of more than 10 inches and have lime below a depth of 18 inches. They are in depressions.

The Colvin soil is moderately slowly permeable. The available water capacity is high. Runoff is very slow. A seasonal high water table fluctuates between depths of 0 and 1 foot. The surface layer is silty clay loam; hard clods form if the soil is tilled when it is too wet and a crust forms following heavy rains.

This soil is used mainly for cultivated crops. It is suited to small grains and sunflowers. Wetness, where the soil is not drained, and controlling soil blowing and maintaining tilth, where the soil is drained, are the main concerns where cultivated crops are grown. Drainage increases suitability for crops; however, increased salinity has been observed in some drained areas. Soil blowing is a moderate hazard. Soil blowing can be controlled by field windbreaks, stripcropping, cover crops, buffer strips, and conservation tillage that leaves crop residue on the

surface. Returning crop residue to the soil increases infiltration, reduces runoff, and maintains or improves soil tilth.

If drained, this soil is suited to trees and shrubs used as windbreaks and environmental plantings. If not drained, it generally is not suited. Measures that control soil blowing help protect seedlings from abrasion.

This soil is poorly suited to use as building sites or for septic tank absorption fields. Surface drains help remove excess surface water. Enlarging the absorption field helps offset the slow absorption of liquid wastes. The seasonal high water table is a continuing limitation for septic tank absorption fields. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements.

The land capability classification of this soil is IIw.

27—Divide loam. This is a level, deep, somewhat poorly drained soil on toe slopes of glacial outwash plains and between beach ridges. The natural drainage pattern is moderately defined. The areas of the soil range from about 10 to 70 acres in size.

Typically, the surface soil is loam about 14 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is loam about 11 inches thick. It is gray in the upper part and light olive brown in the lower part. The substratum, which extends to a depth of 60 inches or more, is light olive brown loam in the upper part and olive stratified sand and gravel in the lower part.

Included with this soil in mapping and making up about 10 to 20 percent of the map unit are small areas of Colvin and Glyndon soils. They are on swales. Colvin soils are poorly drained. They have a surface layer of silty clay loam. The lower part of the substratum is stratified silt loam and silty clay loam. Glyndon soils are somewhat poorly drained and are on swells. They have a silt loam surface layer and substratum.

The Divide soil is moderately permeable in the upper part and very rapidly permeable in the lower part. The available water capacity is moderate. Runoff is slow. A seasonal high water table fluctuates between depths of 2.5 and 5 feet. The surface layer is easily tilled throughout a fairly wide range of moisture content.

This soil is used mainly for cultivated crops. It is suited to small grains and sunflowers. Soil blowing is the main concern in management where cultivated crops are grown. Soil blowing is a moderate hazard. Field windbreaks, stripcropping, cover crops, buffer strips, and conservation tillage that leaves crop residue on the surface help reduce soil blowing. Returning crop residue to the soil improves infiltration and helps maintain or improve tilth.

This soil is suited to trees and shrubs used as windbreaks and environmental plantings. Measures that control soil blowing help protect seedlings from abrasion.

This soil is suited to use as building sites and poorly suited to use as septic tank absorption fields. Surface and foundation drains help overcome wetness on sites for buildings with basements. The sides of basements and other shallow excavations tend to cave in unless they are shored. The seasonal high water table is a continuing limitation for septic tank absorption fields. The soil readily absorbs the effluent in a septic tank absorption field but does not adequately filter it. The poor filtering capacity can result in the pollution of ground water. An alternate system for onsite waste disposal, such as a mound system, can be used in some places.

The land capability classification of this soil is IIIs.

29—Fargo silty clay, saline. This is a level, deep, poorly drained, moderately saline soil on glacial lake plains. This soil is occasionally flooded. The natural drainage pattern is poorly defined. Excess surface water is removed artificially in most areas. The areas of the soil range from 20 to about 300 acres in size.

Typically, the surface layer is black silty clay about 10 inches thick. It has white flecks of salt. The subsoil is silty clay about 12 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The next layer, which extends to a depth of 30 inches, is dark grayish brown silty clay. The substratum is olive gray silty clay to a depth of 60 inches or more. It is mottled at a depth of 45 inches to a depth of 60 inches. In places the surface layer is 11 to 24 inches thick. In some places the surface layer and subsoil are more than 60 percent clay.

Included with this soil in mapping and making up 15 to 25 percent of the map unit are small areas of nonsaline Fargo soils and areas of Hegne and Ryan soils. The nonsaline Fargo soils and this saline Fargo soil are in similar positions on the landscape. Hegne soils are on low swells. They have a layer of accumulated lime within a depth of 16 inches. Ryan soils and the Fargo soil are in similar positions. Ryan soils have a dense subsoil that has excess sodium.

The Fargo soil is slowly permeable. The available water capacity is moderate. Runoff is very slow. A seasonal high water table fluctuates between depths of 0 and 3 feet. Because the surface layer is silty clay, tilth generally is poor.

This soil is used mainly for cultivated crops. This soil is suited to small grains, sunflowers, and grasses and legumes. The high content of salt reduces the water available for plant use; thus, plant growth is restricted. Salt-tolerant crops grow best on this soil. A system of constructed drains removes surface water in most areas. Drainage increases the suitability of the soil for crops; however, increased salinity has been observed in some drained areas. In undrained areas, wetness is a

moderate limitation. Poor workability and soil tilth are the main concerns where the soil is drained and cultivated. Tilling the soil when it is neither too wet nor too dry helps prevent surface compaction and improves soil tilth. Fall plowing generally leaves the soil in good condition for seedbed preparation in the spring; however, it increases the hazard of soil blowing. Soil blowing is a moderate hazard. It can be controlled by the use of buffer strips and conservation tillage that leaves crop residue on the surface.

The Fargo soil is suited to trees and shrubs used as windbreaks and environmental plantings; however, only the most salt-tolerant species should be selected. Drainage increases suitability for this use, but the salinity is a continuing limitation. The seedling survival rate is poor, and the vigor, density, and growth of the surviving trees and shrubs are severely restricted.

The soil is poorly suited to use as building sites. It generally is not suited to use as septic tank absorption fields because of the high clay content, flooding, and slow permeability. Alternate systems of waste disposal, such as a holding tank or a mound system, should be considered. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements. Flooding is a hazard on building sites; however, buildings can be constructed on dikes or mounds that are elevated above the flood plain.

The land capability classification of this soil is IIIs.

31B—Embden fine sandy loam, gravelly substratum, 1 to 6 percent slopes. This is a nearly level and gently sloping, deep, moderately well drained soil on foot slopes of deltas and glacial outwash plains. The areas of the soil range from 10 to about 150 acres in size.

Typically, the surface soil is black fine sandy loam about 11 inches thick. The subsoil is about 20 inches thick. It is very dark grayish brown fine sandy loam in the upper part, dark brown fine sandy loam in the middle part, and light brownish gray very fine sandy loam in the lower part. The next layer, to a depth of 40 inches, is grayish brown fine sandy loam. The substratum, which extends to a depth of 60 inches or more, is brown gravelly loamy sand in the upper part and olive brown stratified sand, silt, clay, and gravel in the lower part. In places the surface layer is light colored loamy fine sand or loamy sand, and it is eroded.

Included with this soil in mapping and making up about 5 to 15 percent of the map unit are small areas of Maddock soils and a well drained soil that has a loamy sand substratum. The well drained Maddock soils are in higher positions on convex slopes. They have a thinner surface layer than that of the Embden soil, and they have more sand. The well drained soil is in lower positions on convex slopes. It has a thinner surface layer than the Embden soil.

The Embden soil is moderately rapidly permeable. The available water capacity is moderate. Runoff is medium. A seasonal high water table fluctuates between depths of 4 and 6 feet. The surface layer is easily tilled throughout a wide range in moisture content.

This soil is used mainly for cultivated crops. It is suited to small grains, corn, and sunflowers. Soil blowing and water erosion are the main concerns in management where cultivated crops are grown. Soil blowing is a severe hazard. It can be controlled by field windbreaks, buffer strips, conservation tillage that leaves crop residue on the surface, and stripcropping. Because the available water capacity is moderate, droughtiness is a concern in management. Crop residue on the soil and green-manure crops help conserve soil moisture.

This Embden soil is suited to trees and shrubs used as windbreaks and environmental plantings. The control or removal of competing vegetation helps seedlings survive and grow. Measures to control soil blowing help protect the seedlings from abrasion.

The soil is suited to building sites and septic tank absorption fields. The seasonal high water table is a continuing limitation for septic tank absorption fields. Foundation drains help overcome wetness, although the sides of basements and other shallow excavations tend to cave in unless they are shored.

The land capability classification of this soil is IIIe.

32—Fargo silty clay, 1 to 3 percent slopes. This is a nearly level, deep, poorly drained soil on broad flats and low ridges on glacial lake plains. The natural drainage pattern is somewhat defined. Excess surface water is removed in most areas by natural and constructed drains. The areas of this soil range from 10 to about 150 acres in size.

Typically, the surface layer is black silty clay about 10 inches thick. The subsoil is silty clay about 12 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The next layer, which extends to a depth of 30 inches, is dark grayish brown silty clay. The substratum is olive gray silty clay to a depth of 60 inches or more. It is mottled at a depth of 45 inches to a depth of 60 inches. In places the surface layer is 11 to 24 inches thick.

Included with this soil in mapping and making up 15 to 25 percent of the map unit are small areas of Hegne and Ryan soils. The Hegne soils are on swells. They have a layer of accumulated lime within a depth of 16 inches. The Ryan soils are in slight swales. They have a dense, compact subsoil and have salts near the surface.

The Fargo soil is slowly permeable. The available water capacity is high. Runoff is slow. A seasonal high water table fluctuates between depths of 0 and 3 feet. Because the surface layer is silty clay, tilth generally is poor.

This soil is used mainly for cultivated crops. It is suited to small grains, corn, sunflowers, soybeans, and sugar beets. Poor workability and poor tilth are the main concerns where cultivated crops are grown. Tilling the soil when it is neither too wet nor too dry helps prevent surface compaction and improves soil tilth. Returning crop residue to the soil also improves tilth. Plowing in the fall generally leaves the soil in good condition for seedbed preparation in the spring; however, it increases the hazard of soil blowing. Soil blowing is a moderate hazard. It can be controlled by buffer strips and conservation tillage that leaves crop residue on the surface.

If drained, the Fargo soil is suited to trees and shrubs used in windbreaks and environmental plantings. Undrained areas generally are too wet. Grasses and weeds should be removed before trees are planted and should be controlled after a windbreak is established.

This soil is poorly suited to use as building sites. It is generally not suited to septic tank absorption fields because of the high clay content and slow permeability. Alternate systems of waste disposal, such as a holding tank or a mound system, should be considered. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements. Flooding on this soil is rare; nevertheless, flooding is a hazard on building sites. Buildings, however, can be constructed on dikes or mounds that are elevated above the flood plain.

The land capability classification of this soil is IIe.

35—Fairdale silt loam, 1 to 3 percent slopes. This is a nearly level, deep, moderately well drained soil on flood plains. This soil is occasionally flooded. The areas of the soil range from 5 to more than 80 acres in size.

Typically, the surface layer is very dark brown stratified silt loam about 6 inches thick. The substratum to a depth of about 60 inches, in sequence downward, is dark grayish brown silt loam, grayish brown silt loam, dark grayish brown loam, and dark grayish brown fine sandy loam. It is mottled at a depth of 6 inches to a depth of 27 inches. In some places the soil is darker colored than is typical to a depth of more than 24 inches, and in a few places the soil is poorly drained.

Included with this soil in mapping and making up about 15 to 25 percent of the map unit are small areas of Cashel, Fargo, Hegne, and LaDelle soils. The Cashel soils have a silty clay surface layer. The Fargo soils are in swales, and the Hegne soils are on swells of the adjacent glacial lake plain. Both soils are poorly drained. The LaDelle soils are on flood plains and on low stream terraces. They have a silty clay loam surface layer.

The Fairdale soil is moderately permeable. The available water capacity is high. Runoff is slow. The surface layer is friable and is easily tilled throughout a wide range in moisture content.

This soil is used mainly for cultivated crops. In a few wooded areas it is used for pasture. This soil is suited to small grains, corn, sunflowers, soybeans, and sugar beets. Flooding after spring snowmelt and after heavy summer storms is a concern. Spring flooding delays seeding in some years. The main management concern, however, is erosion. Tillage that leaves crop residue on the surface helps control soil erosion.

This soil is suited to use as pasture, and this use is effective in controlling soil erosion. The key native plants to manage are big bluestem, green needlegrass, and western wheatgrass. Prolonged overgrazing of the key plants will decrease production, promote the growth of less desirable plants, and increase the risk of erosion. Alternate grazing or deferred grazing, which leaves about 50 percent of the annual growth of the key plants, helps protect the soil and helps maintain the pasture or range in good condition.

This soil is suited to trees and shrubs used as windbreaks or environmental plantings. Grasses and weeds should be removed before trees are planted and should be controlled after a windbreak is established.

This soil generally is not suited to use as building sites or for septic tank absorption fields because of flooding. Better sites that are not subject to flooding generally are nearby.

The land capability classification of this soil is IIc.

36—Fargo silty clay. This is a level, deep, poorly drained soil on glacial lake plains. This soil is occasionally flooded. The natural drainage pattern is poorly defined. Excess surface water in most areas is removed by artificial drainage. Individual areas of this soil range from 20 to about 1,000 acres in size.

Typically, the surface layer is black silty clay about 10 inches thick. The subsoil is silty clay about 12 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The next layer, which extends to a depth of 30 inches, is dark grayish brown silty clay. The substratum to a depth of 60 inches or more is olive gray silty clay. It is mottled at a depth of 45 inches to a depth of 60 inches. In places the surface layer is 11 to 24 inches thick. In some places the surface layer and subsoil are more than 60 percent clay.

Included with this soil in mapping and making up 15 to 25 percent of the map unit are small areas of Cashel, Hegne, Ryan, and Wahpeton soils. The Cashel soils are on flood plains. They have a stratified surface layer. The Hegne soils are on low ridges. They have a layer of lime accumulation within a depth of 16 inches. The Ryan soils and the Fargo soil are in similar positions. Ryan soils have a dense, compact subsoil and have salts near the surface. The Wahpeton soils are on flood plains and on low stream terraces. They have a thicker surface layer than that of the Fargo soil.

The Fargo soil is slowly permeable. The available water capacity is high. Runoff is very slow. A seasonal high water table fluctuates between depths of 0 and 3 feet. Because the surface layer is silty clay, tilth generally is poor.

This soil is used mainly for cultivated crops. It is suited to small grains, corn, sunflowers, soybeans, and sugar beets. A system of constructed drains removes surface water in most areas; thus, the suitability of the soil for crops is increased. In undrained areas, wetness is a moderate limitation. Where the soil is drained and cultivated, poor workability and poor tilth are the main concerns. Tilling the soil when it is neither too wet nor too dry helps prevent surface compaction and improves soil tilth. Returning crop residue to the soil also improves tilth. Plowing in the fall generally leaves the soil in good condition for seedbed preparation in the spring; however, fall plowing increases the hazard of soil blowing. Soil blowing generally is a moderate hazard. Soil blowing can be controlled by the use of buffer strips and conservation tillage that leaves crop residue on the surface.

If drained, this Fargo soil is suited to trees and shrubs used as windbreaks and environmental plantings. If not drained, the soil generally is not suited to this use because of wetness. Grasses and weeds should be removed before trees are planted and should be controlled after a windbreak is established.

This soil is poorly suited to use as building sites. It is generally not suited to use as septic tank absorption fields because of the high clay content, flooding, and slow permeability. Alternate systems of waste disposal, such as a holding tank or a mound system, should be considered. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements. Flooding is a hazard on building sites, but it commonly is overcome by constructing dikes or mounds elevated above the flood plain.

The land capability classification of this soil is IIw.

37—Fargo silty clay, depressional. This is a level, deep, poorly drained soil in swales and shallow depressions on glacial lake plains. The natural drainage pattern is poorly defined, and excess surface water is removed in most areas by artificial drainage. The areas range from 5 to about 50 acres in size.

Typically, the surface layer is black silty clay about 10 inches thick. The subsoil is silty clay about 12 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The layer below the subsoil, from a depth of 22 inches to a depth of 30 inches, is dark grayish brown silty clay. The substratum, which extends to a depth of 60 inches or more, is olive gray silty clay. It is mottled at a depth of 45 inches to a depth of 60 inches. In places the surface layer is 11 to 24 inches thick, and in some places the surface layer and subsoil are more than 60 percent clay.

Included with this soil in mapping and making up 15 to 25 percent of the map unit are small areas of Cashel, Hegne, Ryan, and Wahpeton soils. The Cashel soils are on flood plains. They have a stratified surface layer. The Hegne soils are on swells. They have a layer of accumulated lime within a depth of 16 inches. The Ryan soils and the Fargo soil are in similar positions on the landscape. Ryan soils have a dense, compact subsoil and contain salts near the surface. The Wahpeton soils are on flood plains and on low stream terraces. They have a thicker surface layer than that of the Fargo soil.

The Fargo soil is slowly permeable. The available water capacity is high. Runoff is ponded. A seasonal high water table fluctuates between 6 inches above the surface and 12 inches below the surface. Because the surface layer is silty clay, tilth generally is poor.

This soil is used mainly for cultivated crops. It is suited to small grains, corn, sunflowers, soybeans, and sugar beets. Artificial drainage removes surface water in most areas, thus increasing the suitability of the soil for crops. Tilling the soil when it is neither too wet nor too dry helps prevent surface compaction and improves tilth. Returning crop residue to the soil also helps improve soil tilth. Plowing in the fall generally leaves the soil in good condition for seedbed preparation in the spring; however, the fall plowing increases the hazard of soil blowing. Soil blowing is a moderate hazard. It can be controlled by buffer strips and conservation tillage that leaves crop residue on the surface. In areas that are not artificially drained, wetness is a severe limitation.

If drained, this Fargo soil is suited to trees and shrubs in windbreaks and environmental plantings. Undrained areas generally are too wet. Grasses and weeds should be removed before trees are planted and should be controlled after a windbreak is established.

This soil is poorly suited to use as building sites. Generally, it is not suited to use as septic tank absorption fields because of the high clay content, ponding, and slow permeability. Alternate systems of waste disposal, such as a holding tank or a mound system, should be considered. The shrink-swell potential is a limitation for building sites. Surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by the shrinking and swelling. Surface and foundation drains also help prevent seepage into basements.

The land capability classification of this soil is IIIw.

38—Fargo silty clay loam. This is a level, deep, poorly drained soil on low ridges and broad flats of glacial lake plains. This soil is rarely flooded. The natural drainage pattern is poorly defined. Excess surface water is removed in most areas by artificial drainage. The

areas of the soil range from 20 to about 500 acres in size.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsoil is silty clay about 12 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The next layer, which extends to a depth of 30 inches, is dark grayish brown silty clay. The substratum is olive gray silty clay to a depth of 60 inches or more. It is mottled at a depth of 45 inches to a depth of 60 inches. In places the surface layer is 11 to 24 inches thick.

Included with this soil in mapping and making up 15 to 25 percent of the map unit are small areas of Hegne, Overly, and Ryan soils. The Hegne soils are on swells. They have a layer of accumulated lime within a depth of 16 inches. The Overly soils are moderately well drained and have a silty clay loam subsoil. The Ryan soils are in positions similar to those of the Fargo soil. They have a dense, compact subsoil and have salts near the surface.

The Fargo soil is slowly permeable. The available water capacity is high. Runoff is very slow. A seasonal high water table fluctuates between depths of 0 and 3 feet. Because the surface layer is silty clay loam, tilth generally is only fair.

This soil is used mainly for cultivated crops. It is suited to small grains, corn, sunflowers, soybeans, and sugar beets. A system of constructed drains removes surface water in most areas; thus, the suitability of the soil for crops is increased. In undrained areas, wetness is a moderate limitation. Where the soil is drained and cultivated, poor tilth is the main concern. Tilling the soil when it is neither too wet nor too dry helps prevent surface compaction and improves soil tilth. Returning crop residue to the soil also improves tilth. Plowing in the fall generally leaves the soil in good condition for seedbed preparation in the spring; however, fall plowing increases the hazard of soil blowing. Soil blowing can be controlled by the use of buffer strips and conservation tillage that leaves crop residue on the surface.

If drained, the Fargo soil is suited to the trees and shrubs used as windbreaks and environmental plantings. Undrained areas generally are too wet. Grasses and weeds should be removed before trees are planted and should be controlled after a windbreak is established.

This soil is poorly suited to use as building sites, and generally it is not suited to use as septic tank absorption fields because of the high clay content and slow permeability. Alternate systems of waste disposal, such as a holding tank or a mound system, should be considered. The shrink-swell potential is a limitation for building sites. Surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements. Constructing dikes or mounds that are elevated above the flood plain help overcome the hazard of flooding.

The land capability classification of this soil is IIw.

39—Galchutt silt loam. This is a level, deep, somewhat poorly drained soil in swales of glacial lake plains. The natural drainage pattern is poorly defined. Excess surface water is removed in most areas by artificial drainage. The areas of this soil range from 20 to about 500 acres in size.

Typically, the surface soil is 17 inches thick. It is black silt loam in the upper part and very dark gray loam in the lower part. The subsurface layer is mottled dark grayish brown very fine sandy loam about 8 inches thick. The subsoil is mottled, olive gray silty clay about 6 inches thick. The substratum to a depth of 60 inches or more is mottled, olive gray silty clay.

Included with this soil in mapping and making up about 15 to 25 percent of the map unit are small areas of Bearden, Fargo, and Gardena soils. The Bearden soils are on swells. They have a layer of accumulated lime within a depth of 16 inches. The Fargo soils are in swales. They have a silty clay surface layer. The Gardena soils are on low ridges and swells. They have a silt loam subsoil and substratum.

The Galchutt soil is slowly permeable. The available water capacity is high. Runoff is very slow. A seasonal high water table fluctuates between depths of 1 and 3 feet. The surface layer is easily tilled throughout a wide range of moisture content.

This soil is used mainly for cultivated crops. It is well suited to small grains, corn, sunflowers, soybeans and sugar beets. Artificial drainage removes surface water in most areas, thus improving the suitability of the soil for crops. In areas that are not drained, wetness is a moderate limitation. Soil blowing is a hazard on drained cropland, but it can be controlled by buffer strips and by conservation tillage that leaves crop residue on the surface.

This soil is suited to trees and shrubs used as windbreaks and environmental plantings. Grasses and weeds should be removed before trees are planted and should be controlled after a windbreak is established.

This soil is poorly suited to use as building sites, and generally it is not suited to use as septic tank absorption fields because of slow permeability, high clay content, and wetness. Alternate systems of waste disposal, such as a holding tank or a mound system, should be considered. The shrink-swell potential is a limitation for building sites. Surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements.

The land capability classification of this soil is IIw.

40—Fargo-Hegne silty clays. This complex consists of level, deep, poorly drained soils on glacial lake plains. The Fargo soil is in swales. The Hegne soil is on swells.

The Fargo soil is occasionally flooded. The Hegne soil is rarely flooded. The natural drainage pattern is poorly defined. In most areas, excess surface water is removed by a system of constructed drains. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are 60 percent Fargo soil and 30 percent Hegne soil. The areas range from about 20 to 100 acres in size.

Typically, the Fargo soil has a black silty clay surface layer about 10 inches thick. The subsoil is silty clay about 12 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The next layer, which extends to a depth of 30 inches, is dark grayish brown silty clay. The substratum to a depth of 60 inches or more is olive gray silty clay. It is mottled at a depth of 45 inches to a depth of 60 inches. In places the surface layer is silty clay loam. In other places the surface layer is 11 to 24 inches thick. In some places the surface layer and subsoil are more than 60 percent clay.

Typically, the Hegne soil has a black silty clay surface layer about 7 inches thick. The subsoil is dark gray silty clay about 24 inches thick. The substratum to a depth of 60 inches or more is olive gray silty clay. It is mottled at a depth of 46 inches to a depth of 60 inches.

Included with these soils in mapping and making up about 10 percent of the map unit are small areas of Dovray soils. The Dovray soils are in depressions and narrow drainageways. They are very poorly drained and have a surface soil that is more than 24 inches thick.

The Fargo soil is slowly permeable, and the Hegne soil is very slowly permeable. The available water capacity is high. Runoff is very slow. A seasonal high water table is at a depth of 0 to 3 feet in the Fargo soil and at 1 to 2.5 feet in the Hegne soil. Because the surface layer is silty clay, tilth generally is poor.

These soils are used mainly for cultivated crops. They are well suited to small grains, soybeans, sunflowers, sugar beets, and alfalfa. A system of constructed drains removes surface water in most areas, thus increasing the suitability of the soils for crops. Yearly maintenance is required to keep the drains open. In undrained areas, wetness is a severe limitation. Tilling the soil when it is neither too wet nor too dry helps prevent soil compaction and improves soil tilth. Returning crop residue to the soil also improves soil tilth. Plowing in the fall generally leaves the soil in good condition for seedbed preparation in the spring; however, fall plowing increases the hazard of soil blowing. Soil blowing is a moderate hazard. It can be controlled by the use of buffer strips and conservation tillage that leaves crop residue on the surface.

If drained, these soils are suited to trees and shrubs used as windbreaks or environmental plantings. Undrained areas generally are too wet. Measures that control soil blowing protect seedlings from abrasion.

These soils are poorly suited to use as building sites, and generally they are not suited to use as septic tank absorption fields because of high clay content, flooding, and slow permeability. Alternate systems of waste disposal, such as a holding tank or a mound system, should be considered. The shrink-swell potential is a limitation for building sites. Surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements. Constructing dikes or mounds that are elevated above the flood plain helps prevent damage to buildings from flooding.

The land capability classification of these soils is IIw.

41—Hegne-Fargo silty clay loams. This complex consists of level, deep, poorly drained soils on glacial lake plains. The Hegne soil is on swells. The Fargo soil is in swales. The Hegne soil is rarely flooded. The Fargo soil is occasionally flooded. The natural drainage pattern is poorly defined. In most areas, excess surface water is removed by a system of constructed drains. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are about 60 percent Hegne soil and 20 to 30 percent Fargo soil. The areas range from about 20 to 1,000 acres in size.

Typically, the Hegne soil has a black silty clay loam surface layer about 7 inches thick. The subsoil is dark gray silty clay about 24 inches thick. The substratum to a depth of 60 inches or more is olive gray silty clay. It is mottled at a depth of 46 inches to a depth of 60 inches.

Typically, the Fargo soil has a black silty clay loam surface layer about 10 inches thick. The subsoil is silty clay about 12 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The next layer, which extends to a depth of 30 inches, is dark grayish brown silty clay. The substratum to a depth of 60 inches or more is olive gray silty clay. It is mottled at a depth of 45 inches to a depth of 60 inches. In places the surface layer is silty clay. In other places the surface layer is 11 to 24 inches thick. In some places, there is a thin light colored subsurface layer.

Included with these soils in mapping and making up about 10 to 20 percent of the map unit are small areas of Dovray soils. The Dovray soils are in depressions and narrow drainageways. They are very poorly drained and have a dark colored surface soil that is more than 24 inches thick.

The Hegne soil is very slowly permeable, and the Fargo soil is slowly permeable. The available water capacity is high. Runoff is very slow. A seasonal high water table is at a depth of 1 to 2.5 feet in the Hegne soil and at 0 to 3 feet in the Fargo soil. Because the surface layer is silty clay loam, tilth generally is only fair.

These soils are used mainly for cultivated crops. They are well suited to small grains, soybeans, dry beans, sunflowers, sugar beets, and alfalfa. A system of constructed drains removes surface water in most areas,

thus increasing the suitability of the soils for crops. Yearly maintenance is required to keep the drains open. In undrained areas, wetness is a moderate limitation. Tilling the soil when it is neither too wet nor too dry helps prevent surface compaction and improves soil tilth. Returning crop residue to the soil also improves soil tilth. Plowing in the fall generally leaves the soil in good condition for seedbed preparation in the spring; however, fall plowing increases the hazard of soil blowing. Soil blowing is a moderate hazard, particularly on the Hegne soil, but it can be controlled by the use of buffer strips and conservation tillage that leaves crop residue on the surface.

If drained, these soils are suited to the trees and shrubs used as windbreaks or environmental plantings. Undrained areas generally are too wet. Measures that control soil blowing help protect seedlings from abrasion.

The soils are poorly suited to use as building sites and generally they are not suited to use as septic tank absorption fields because of the high clay content, flooding, and slow permeability. Alternate systems of waste disposal, such as a holding tank or a mound system, should be considered. The shrink-swell potential is a limitation for building sites. Surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements. Damage to buildings from flooding commonly is prevented by constructing dikes or mounds that are elevated above the flood plain.

The land capability classification of these soils is IIw.

43—Gardena silt loam. This is a level, deep, moderately well drained soil on low ridges and deltas on glacial lake plains. The areas range from 10 to 100 acres in size.

Typically, the surface soil is black silt loam about 11 inches thick. The subsoil is silt loam about 14 inches thick. It is black in the upper part, very dark grayish brown in the middle part, and grayish brown in the lower part. The substratum to a depth of 60 inches or more is mottled silt loam. It is grayish brown in the upper part and light yellowish brown in the lower part.

Included with this soil in mapping and making up about 5 to 25 percent of the map unit are small areas of Galchutt and Tiffany soils. The Galchutt soils are in swales. They are somewhat poorly drained. The Tiffany soils are in depressions. They are poorly drained.

The Gardena soil is moderately permeable. The available water capacity is high. Runoff is slow. A seasonal high water table fluctuates between depths of 4 and 6 feet. The surface layer is easily tilled throughout a wide range of moisture content.

This soil is used mainly for cultivated crops. The soil is suited to small grains, corn, sunflowers, soybeans, and sugar beets. Soil blowing is a concern where cultivated crops are grown. Stripcropping, buffer strips, windbreaks, and conservation tillage that leaves crop residue on the surface help control soil blowing.

This soil is suited to trees and shrubs used as windbreaks or environmental plantings. No critical limitations affect trees and shrubs.

This soil is suited to use as building sites and for septic tank absorption fields. The seasonal high water table is a continuing limitation for septic tank absorption fields. Surface and foundation drains help prevent seepage into basements.

The land capability classification of this soil is IIe.

46—Gardena-Glyndon silt loams, 0 to 3 percent slopes. This complex consists of level and nearly level, deep soils on glacial lake plains. The Gardena soil is moderately well drained and is on swells. The Glyndon soil is somewhat poorly drained and is in swales. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are 50 to 60 percent Gardena soil and 30 to 35 percent Glyndon soil. The areas range from about 20 to 200 acres in size.

Typically, the Gardena soil has a black silt loam surface soil about 11 inches thick. The subsoil is silt loam about 14 inches thick. It is black in the upper part, very dark grayish brown in the middle part, and grayish brown in the lower part. The substratum is mottled silt loam to a depth of 60 inches or more. It is grayish brown in the upper part and light yellowish brown in the lower part. In some places the surface layer is 8 to 11 inches thick.

Typically, the Glyndon soil has a surface soil of black silt loam about 12 inches thick. The subsoil is mottled silt loam about 16 inches thick. It is dark grayish brown in the upper part and olive brown in the lower part. The substratum to a depth of 60 inches or more is light olive brown and is mottled. It is very fine sandy loam in the upper part and stratified silt loam in the lower part. In some places the surface layer and substratum are silty clay loam.

Included with these soils in mapping and making up 5 to 20 percent of the map unit are small areas of Tiffany and Wyndmere soils. The Tiffany soils are poorly drained and are in swales. The Wyndmere soils are somewhat poorly drained. Their surface layer is loam and the lower part of the substratum is fine sandy loam.

The Gardena soil is moderately permeable, and the Glyndon soil is moderately rapidly permeable. The available water capacity is high. Surface runoff is slow. The surface layer is easily tilled throughout a wide range of moisture content. A seasonal high water table is at a depth of 4 to 6 feet in the Gardena soil and at a depth of 2.5 to 6 feet in the Glyndon soil.

These soils are used mainly for cultivated crops. They are suited to small grains, corn, soybeans and sunflowers. Soil blowing is a moderate hazard on the Glyndon soil. It is the main concern in management

where cultivated crops are grown. Conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help control soil blowing.

These soils are suited to trees and shrubs used as windbreaks or environmental plantings. Measures that control soil blowing help protect seedlings from abrasion.

These soils are suited to use as septic tank absorption fields and as building sites. Wetness is a limitation for absorption fields, particularly on the Glyndon soil. Surface and foundation drains help prevent seepage into basements. The sides of basements and other shallow excavations in the Glyndon soil tend to cave in unless they are shored.

The land capability classification of this complex is IIe.

47—Fargo silty clay, smooth surface. This is a level, deep, poorly drained soil that is adjacent to streams on glacial lake plains. This soil is occasionally flooded. The natural surface drainage pattern is well defined. Surface water flows away from and lateral to the adjacent streams until a channel is cut to the stream. The areas of this soil range from 20 to about 100 acres in size.

Typically, the surface layer is black silty clay about 10 inches thick. The subsoil is silty clay about 12 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The next layer, which extends to a depth of 30 inches, is dark grayish brown silty clay. The substratum is olive gray silty clay to a depth of about 60 inches or more. It is mottled at a depth of 45 inches to a depth of 60 inches. In places the surface layer is 11 to 24 inches thick.

Included with this soil in mapping and making up 15 to 25 percent of the map unit are small areas of Cashel, Hegne, Ryan, and Wahpeton soils. The Cashel soils are on flood plains. They have a stratified surface layer. The Hegne soils are on low ridges. They have a layer of accumulated lime within a depth of 16 inches. The Ryan soils and the Fargo soils are in similar positions. Ryan soils have a dense, compact subsoil and have salts near the surface. The Wahpeton soils are on flood plains and on low stream terraces. They have a thicker surface layer than that of the Fargo soil.

The Fargo soil is slowly permeable. The available water capacity is high. Runoff is very slow. A seasonal high water table fluctuates between depths of 0 and 3 feet. Because the surface layer is silty clay, tilth generally is poor.

This soil is used mainly for cultivated crops. It is suited to small grains, corn, sunflowers, soybeans, and sugar beets. Natural surface drainage is good. Most areas of this soil, however, are crossed by a drainage system installed to drain adjacent soils. Tilling the soil when it is neither too wet nor too dry helps prevent surface compaction and helps improve tilth. Returning crop residue to the soil also improves tilth. Plowing in the fall generally leaves the soil in good condition for seedbed preparation in the spring; however, fall plowing increases the hazard of soil blowing. Soil blowing is a moderate hazard. It can be controlled by buffer strips and conservation tillage that leaves crop residue on the surface.

If drained, the Fargo soil is suited to trees and shrubs used as windbreaks or environmental plantings. Undrained areas generally are too wet. Grasses and weeds should be removed before trees are planted and should be controlled after a windbreak is established.

This soil is poorly suited to use as building sites. It is generally not suited to use as septic tank absorption fields because of the high clay content, flooding, and slow permeability. Alternate systems of waste disposal, such as a holding tank or a mound system, should be considered. The shrink-swell potential is a limitation for building sites. Surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements. Constructing dikes or mounds that are elevated above the flood plain help prevent damage to buildings from occasional flooding.

The land capability classification of this soil is IIw.

48—Glyndon silt loam, 0 to 3 percent slopes. This is a level and nearly level, deep, somewhat poorly drained soil on swells on glacial lake plains. The natural drainage pattern is poorly defined. In most areas, excess surface water is removed by a system of constructed drains. Individual areas of this soil range from 20 to 200 acres in size.

Typically, the surface soil is black silt loam about 12 inches thick. The subsoil is mottled silt loam about 16 inches thick. It is dark grayish brown in the upper part and olive brown in the lower part. The substratum to a depth of 60 inches or more is light olive brown and is mottled. It is very fine sandy loam in the upper part and stratified silt loam in the lower part. In places the surface layer is loam. In other places the soil contains more sand throughout than is typical.

Included with this soil in mapping and making up about 5 to 25 percent of the map unit are small areas of Colvin, Perella, Tiffany, and Wyndmere soils. The Colvin soils are in swales. They are poorly drained and have a silty clay loam surface layer. Perella soils are in depressions. They are poorly drained and have a silty clay loam surface layer. Tiffany soils are in depressions. They are poorly drained and have mottles near the surface. Wyndmere soils are on swells and have a loam surface layer. Also included are some areas where the slopes are 3 to 6 percent.

The Glyndon soil is moderately rapidly permeable. The available water capacity is high. Runoff is slow. A seasonal high water table fluctuates between depths of 2.5 and 6 feet. The surface layer is easily tilled throughout a wide range of moisture content.

This soil is used mainly for cultivated crops. It is suited to small grains, corn, sunflowers, soybeans, and sugar beets. Surface water is removed by artificial drainage in most areas, thus increasing the suitability of the soil for crops. In areas that are not drained, seeding is sometimes delayed. The common crops are grown each year, but soil blowing is a moderate hazard. It can be controlled by stripcropping, buffer strips, windbreaks, and conservation tillage that leaves crop residue on the surface.

This Glyndon soil is suited to trees and shrubs used as windbreaks or environmental plantings. Measures that control soil blowing help protect seedlings from abrasion.

This soil is poorly suited to use as septic tank absorption fields and as building sites. The seasonal high water table is a limitation for septic tank absorption fields. An alternate system for onsite waste disposal, such as a mound system, can be used in some areas. Surface and foundation drains help prevent seepage into basements. The sides of basements and other shallow excavations tend to cave in unless they are shored.

The land capability classification of this soil is IIe.

49—Glyndon silt loam, saline, 0 to 3 percent slopes. This is a level and nearly level, deep, somewhat poorly drained, moderately saline soil on swells of glacial lake plains. The areas of the soil range from 10 to more than 200 acres in size.

Typically, the surface soil is black silt loam about 12 inches thick. It has white flecks of salt. The subsoil is mottled silt loam about 16 inches thick. It is dark grayish brown in the upper part and olive brown in the lower part. The substratum to a depth of 60 inches or more is light olive brown and is mottled. It is very fine sandy loam in the upper part and stratified silt loam in the lower part.

Included with this soil in mapping and making up about 5 to 15 percent of the map unit are small areas of Bearden and Wyndmere soils. The Bearden soils are somewhat poorly drained and have a silty clay loam surface layer. The Wyndmere soils have more sand and less silt than Glyndon soils.

The Glyndon soil is moderately rapidly permeable. The available water capacity is moderate. Runoff is slow. A seasonal high water table fluctuates between depths of 2.5 and 6 feet. The surface layer is easily tilled throughout a wide range of moisture content. The high salt content of the soil restricts plant growth (fig. 11).

This unit is used mainly for cultivated crops. It is poorly suited to small grains and sunflowers and is best suited to salt-tolerant crops. Soil blowing, wetness, and salinity are major concerns in management where cultivated crops are grown. Soil blowing is a moderate hazard. Conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help control soil blowing. Artificial drainage helps reduce wetness but can cause increased salinity.

The Glyndon soil is suited to trees and shrubs used as windbreaks or environmental plantings, but only the most salt-tolerant species should be selected for planting. The seedling mortality rate is high, and the growth of the surviving trees and shrubs is severely restricted.

This soil is poorly suited to use as building sites and for septic tank absorption fields. The seasonal high water table is a limitation for absorption fields. An alternate system for onsite waste disposal, such as a mound sewage disposal system or holding tank system, can be used in some areas. Surface and foundation drains help prevent seepage into basements. The sides of basements and other shallow excavations tend to cave in unless they are shored.

The land capability classification of this soil is IIIs.

50—Hamerly-Tonka loams, 0 to 3 percent slopes. This complex consists of level and nearly level, deep soils on glacial till plains. The level and nearly level Hamerly soil is on toe slopes and between and surrounding depressions. It is somewhat poorly drained. The level Tonka soil is in depressions. It is poorly drained. In most areas, the natural drainage system is not well developed. Excess water from spring runoff and heavy rains frequently ponds in depressions. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are 50 to 60 percent Hamerly soil and 30 to 35 percent Tonka soil. The areas range from about 5 to 200 acres in size.

Typically, the Hamerly soil has a black loam surface layer about 10 inches thick. The subsoil is grayish brown loam about 14 inches thick. The substratum to a depth of 60 inches or more is loam. It is olive in the upper part and mottled light olive brown in the lower part. In some areas, generally the higher lying slopes, the calcareous layer is more than 16 inches below the surface. In other areas, generally the lower lying areas, the lower part of the substratum is grayish brown.

Typically, the Tonka soil has a black loam surface layer about 7 inches thick. The subsurface layer is loam about 8 inches thick. It is very dark gray in the upper part and mottled grayish brown in the lower part. The subsoil, which is about 25 inches thick, is mottled very dark grayish brown silty clay loam in the upper part and mottled dark grayish brown clay loam in the lower part. The substratum to a depth of 60 inches or more is mottled grayish brown. It is clay loam in the upper part and loam in the lower part. In some areas, generally the deeper part of depressions, the subsurface layer is thinner than is typical, or there is no subsurface layer.

Included with these soils in mapping and making up 5 to 20 percent of the map unit are small areas of Wyard soils. Like the Hamerly soil, Wyard soils are somewhat poorly drained, but they are on foot slopes and on toe slopes below the Hamerly soil.

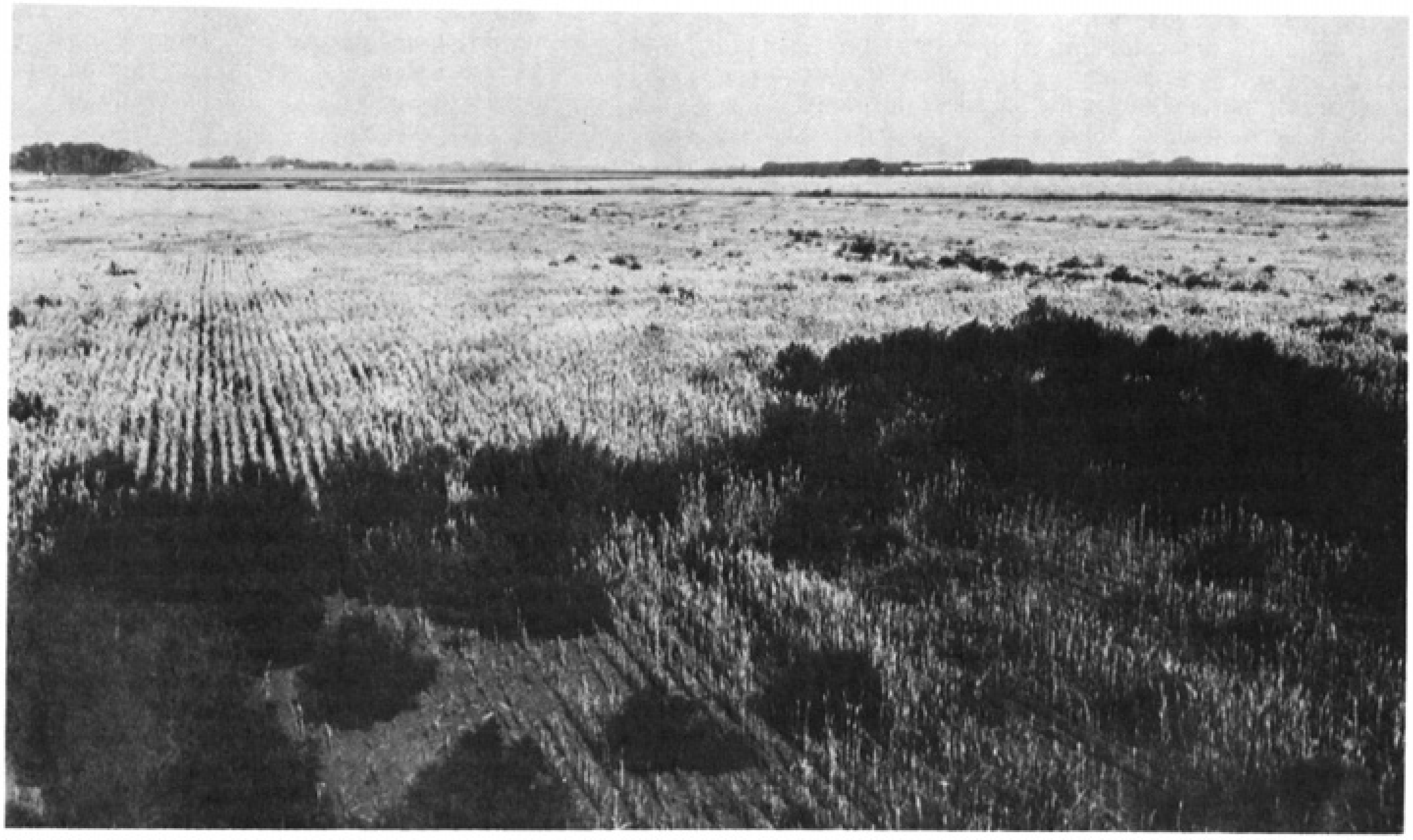

Figure 11.—Kochia, a common weed, growing prominently in the foreground, is indicative of a saline soil. The soil here is Glyndon silt loam, saline, 0 to 3 percent slopes.

The Hamerly soil is moderately slowly permeable, and the Tonka soil is slowly permeable. The available water capacity is high. Runoff is slow on the Hamerly soil and ponded on the Tonka soil. A seasonal high water table is at a depth of 2 to 4 feet in the Hamerly soil and between 6 inches above the surface and 12 inches below the surface in the Tonka soil. The surface layer is easily tilled throughout a wide range of moisture content.

These soils are used mainly for cultivated crops. They are suited to small grains and sunflowers. In most years, they are best suited to late seeded crops. Wetness and ponding are the main concerns where cultivated crops are grown. Ponding on the Tonka soil limits crop growth and is a hazard to harvesting in some years. Drainage increases the suitability of the soils for crops, but outlets for surface drains generally are difficult to locate. Soil blowing is a hazard in cultivated areas, especially on fields that are plowed in the fall. The Hamerly soil particularly is susceptible to soil blowing. Field windbreaks, stripcropping, buffer strips, and conservation tillage that leaves crop residue on the surface help control soil blowing.

The Hamerly soil is suited to trees and shrubs used as windbreaks or environmental plantings. If not drained, the Tonka soil generally is not suited to this use because of wetness and ponding. Measures to control soil blowing help minimize abrasion of seedlings.

Because of wetness, the Hamerly soil is poorly suited to use as septic tank absorption fields and as building sites. The Tonka soil generally is not used for building sites or septic tank absorption fields because of ponding. Installing a drainage system and diverting surface runoff help reduce wetness on building sites, but the seasonal high water table remains a continuing limitation for septic tank absorption fields. On the Hamerly soil, enlarging the absorption field generally is needed to offset the slow absorption of liquid wastes. The moderate shrink-swell potential of the Hamerly soil is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements.

The land capability classification of these soils is IIe.

50B—Hamerly loam, 3 to 6 percent slopes. This is a gently sloping, deep, somewhat poorly drained soil on toe slopes of glacial till plains. Individual areas of this soil range from 10 to 60 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsoil is grayish brown loam about 14 inches thick. The substratum to a depth of 60 inches or more is loam. It is olive in the upper part and mottled light olive brown in the lower part.

Included with this soil in mapping and making up 5 to 15 percent of the map unit are small areas of Vallers, Tonka, and Wyard soils. The poorly drained Vallers soils are on the rim of depressions below the Hamerly soil. They have an olive gray lower substratum. The poorly drained Tonka soils are in depressions. They have a light colored subsurface layer. The somewhat poorly drained Wyard soils are on toe slopes below the Hamerly soil.

The Hamerly soil is moderately slowly permeable. The available water capacity is high. Runoff is slow. A seasonal high water table fluctuates between depths of 2 and 4 feet. The surface layer is easily tilled throughout a wide range of moisture content.

This soil is used mainly for cultivated crops. The soil is suited to small grains, corn, and sunflowers. Controlling soil blowing and water erosion are concerns where cultivated crops are grown. Soil blowing is a moderate hazard. Intensive use of annual buffer strips and conservation tillage that leaves crop residue on the surface help reduce soil blowing and water erosion.

This soil is suited to trees and shrubs used as windbreaks and environmental plantings. Measures that control soil blowing help minimize abrasion of seedlings.

This soil is poorly suited to use as septic tank absorption fields and building sites. The slow absorption of liquid wastes in a septic tank absorption field can be offset by enlarging the absorption field. The seasonal high water table is a continuing limitation for absorption fields. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements.

The land capability classification of this soil is IIe.

51—Hamerly loam, saline, 0 to 3 percent slopes. This is a level and nearly level, deep, somewhat poorly drained, moderately saline soil on toe slopes of glacial till plains. Individual areas range from 10 to 60 acres in size.

Typically, the surface layer is black loam about 10 inches thick. It contains white flecks of salt. The subsoil is grayish brown loam about 14 inches thick. The substratum to a depth of 60 inches or more is loam. It is olive in the upper part and mottled light olive brown in the lower part.

Included with this soil in mapping and making up from 1 to 15 percent of the map unit are small areas of Tonka and Wyard soils and nonsaline Hamerly and Vallers soils. The poorly drained Tonka soils are in depressions. They have a light colored subsurface layer. The poorly drained Vallers soils surround the depressions. They have an olive gray lower substratum. The somewhat poorly drained Wyard soils are on toe slopes below the Hamerly soil.

The Hamerly soil is moderately slowly permeable. The available water capacity is moderate. Runoff is slow. A seasonal high water table fluctuates between depths of 2 and 4 feet. The high salt content of this soil restricts plant growth. The surface layer is easily tilled throughout a wide range of moisture content.

This soil is used mainly for cultivated crops. This soil is poorly suited to small grains and sunflowers. Wetness, salinity, and soil blowing are concerns where cultivated crops are grown. Adequate outlets for drainage water generally are difficult to locate. Surface drains reduce the wetness problem. Planting salt-tolerant crops, avoiding summer fallow, and avoiding deep tillage reduce the salinity problem. Increased salinity has been observed in some drained areas. Soil blowing is a moderate hazard. Intensive use of annual buffer strips and conservation tillage that leaves crop residue on the surface help reduce soil blowing.

This soil is suited to trees and shrubs used as windbreaks or environmental plantings. Only the most salt-tolerant species, however, should be selected. The seedling survival rate is poor, and the vigor, density, and height of the surviving trees and shrubs are severely restricted.

This soil is poorly suited to use as septic tank absorption fields and building sites. The slow absorption of liquid wastes in a septic tank absorption field can be offset by enlarging the absorption field. The seasonal high water table is a continuing limitation for absorption fields. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements.

The land capability classification of this soil is IIIs.

54—Lamoure silty clay loam. This is a level, deep, poorly drained soil on flood plains that are dissected into small irregularly shaped areas by deep channels or steep escarpments. This soil is occasionally flooded. Individual areas range from 5 to about 350 acres in size.

Typically, the surface soil is about 25 inches thick. It is black silty clay loam in the upper part, black silt loam in the middle part, and mottled very dark gray silt loam in the lower part. The substratum to a depth of 60 inches or more is mottled grayish brown. It is silt loam in the upper part and stratified loam and silty clay loam in the

lower part. In some areas the surface layer is silt loam. In some places a calcareous layer is within a depth of 16 inches.

Included with this soil in mapping and making up about 5 to 20 percent of the map unit are small areas of Colvin and LaDelle soils. The Colvin soils are poorly drained. They have a layer of lime accumulation within a depth of 16 inches. The LaDelle soils are higher on the flood plains than the Lamoure soil, and they are better drained.

The Lamoure soil is moderately permeable. The available water capacity is high. Runoff is slow. A seasonal high water table fluctuates between depths of 0 and 2 feet. Because the surface soil is silty clay loam, tilth generally is only fair.

This soil is used mainly for pasture or hay. This soil is poorly suited to small grains and sunflowers. Wetness, flooding, and soil blowing are the main concerns if cultivated crops are grown. Drainage increases the suitability of the soil for crops, but seasonal flooding remains a hazard. The use of cover crops, buffer strips, and conservation tillage that leaves crop residue on the surface help reduce soil blowing.

This soil is suited to pasture and hay, and this use is effective in reducing soil blowing. Drainage increases the suitability for hay. Wetness interferes with haying operations in some years. The key native plants to manage are big bluestem and switchgrass. Alternate grazing and deferred grazing, which leave about 50 percent of the annual growth of the native plants, help keep the soil and pasture in good condition.

If drained, this soil is suited to trees and shrubs used as windbreaks or environmental plantings. If not drained, the soil generally is not suited to this use because of wetness. Measures to control soil blowing help minimize abrasion of seedlings.

This soil generally is not suited to use as septic tank absorption fields or as building sites because of flooding and wetness. In this survey area, the Lamoure soil generally is not used for building sites or septic tank absorption fields. Soils that are better suited generally are nearby.

The land capability classification of this soil is IVw.

55—LaDelle silty clay loam. This is a level, deep, moderately well drained soil on low terraces and flood plains. This soil is occasionally flooded. The areas of this soil range from 10 to about 200 acres in size.

Typically, the surface soil is black silty clay loam about 14 inches thick. The subsoil is very dark gray silty clay loam about 19 inches thick. The substratum, which extends to a depth of 60 inches or more, is very dark grayish brown silty clay loam in the upper part, very dark gray silty clay loam in the middle part, and grayish brown stratified loam and clay loam in the lower part.

Included with this soil in mapping and making up 10 to 20 percent of the map unit are small areas of Fairdale, Fairdale Variant, Lamoure, and Overly soils. Fairdale soils are in lower positions on the flood plains and contain more sand. Fairdale Variant soils are on levees and contain more clay in the substratum. Lamoure soils are in swales on the flood plain and are poorly drained. Overly soils are on adjacent glacial lake plains.

The LaDelle soil is moderately permeable. The available water capacity is high. Runoff is slow. A seasonal high water table fluctuates between depths of 4 and 6 feet. Because the surface layer is silty clay loam, tilth generally is only fair.

This soil is used mainly for cultivated crops. In a few wooded areas it is used as pasture. This soil is suited to small grains, corn, sunflowers, and soybeans. Flooding sometimes delays spring planting. Tilth is a concern in management in cultivated areas. Tilling the soil when it is either too wet or too dry can cause surface compaction and poor tilth. Returning crop residue to the soil improves tilth. Plowing in the fall generally leaves the soil in good condition for seedbed preparation in the spring; however, fall plowing increases the hazard of soil blowing. It can be controlled by buffer strips and by conservation tillage that leaves crop residue on the surface.

The LaDelle soil is suited to trees and shrubs used as windbreaks or environmental plantings. Grasses and weeds should be removed before trees are planted and should be controlled after a windbreak is established.

This soil is suited to pasture, and this effectively controls soil erosion. The key native plants to manage are big bluestem, green needlegrass, and western wheatgrass. Overgrazing promotes growth of the less desirable plants and increases the risk of erosion. A system of grazing—alternate and deferred—that leaves about 50 percent of the annual growth of the key plants on the soil helps prevent erosion and helps maintain the pasture in good condition.

This soil generally is not suitable for use as building sites or septic tank absorption fields because of flooding. Generally, sites that are not subject to flooding are nearby.

The land capability classification of this soil is IIc.

57—Fairdale silt loam, channeled. This is a level, deep, moderately well drained soil on flood plains. This soil is frequently flooded. Most areas are fragmented by meandering channels and short, steep escarpments. The areas of this soil range from 5 acres to more than 80 acres in size.

Typically, the surface layer is very dark brown stratified silt loam about 6 inches thick. The substratum in sequence to a depth of 60 inches or more is dark grayish brown silt loam, grayish brown silt loam, dark grayish brown loam, and dark grayish brown fine sandy loam. It is mottled at a depth of 6 inches to a depth of 27 inches. In some places the soil is darker than is

typical to a depth of more than 24 inches. Also, in a few places the soil is poorly drained.

Included with this soil in mapping and making up about 15 to 25 percent of the map unit are small areas of Cashel, Fargo, Hegne, and LaDelle soils. The Cashel soils have a silty clay surface layer. The Fargo soils are in swales, and the Hegne soils are on swells of the adjacent glacial lake plain. The LaDelle soils are on levees and low stream terraces. They are moderately well drained and have a silty clay loam surface layer.

The Fairdale soil is moderately permeable. The available water capacity is high. Runoff is slow.

This soil is best suited to pasture and wildlife habitat. It generally is not suited to cultivated crops because of its rough channeled topography. Pasture plants effectively control soil erosion on this soil. The key plant to manage is big bluestem. Overgrazing decreases production. It promotes growth of the less desirable plants and increases the risk of erosion. Grazing—alternate and deferred—that leaves about 50 percent of the annual growth of the key plant on the soil helps prevent soil erosion and helps maintain the pasture in good condition.

This soil is suited to the trees and shrubs used as windbreaks or environmental plantings. Grasses and weeds should be removed before trees are planted and should be controlled after a windbreak is established. Mechanical equipment is difficult to use because of the slope.

This soil generally is not suitable for use as building sites or septic tank absorption fields because of flooding. Generally, sites that are not subject to flooding are nearby.

The land capability classification of this soil is VIw.

58B—Maddock fine sandy loam, 1 to 6 percent slopes. This is a nearly level and gently sloping, deep, well drained soil on low ridges and knobs of glacial lake plains and delta plains. Individual areas range from 10 to about 40 acres in size.

Typically, the surface layer is black fine sandy loam about 7 inches thick. The subsoil is very dark grayish brown loamy fine sand about 6 inches thick. The substratum, which extends to a depth of 60 inches or more, is olive brown loamy sand in the upper part and grayish brown loamy fine sand in the lower part. In places the soil is loamy coarse sand throughout. In other places the surface is light colored loamy fine sand or loamy sand and is eroded.

Included with this soil in mapping and making up about 5 to 15 percent of the map unit are small areas of Embden and Renshaw soils and areas of a moderately well drained soil that has a loamy sand substratum. The moderately well drained Embden soils are on lower lying concave slopes. They have a thicker surface layer than that of the Maddock soil, and they have more silt. The somewhat excessively drained Renshaw soils are on shoulder slopes. They have a very gravelly loamy sand lower substratum. The moderately well drained soil that has the loamy sand substratum is on lower lying concave slopes. It has a thicker surface layer than that of the Maddock soil.

The Maddock soil is rapidly permeable. The available water capacity is low. Runoff is slow. The surface layer is easily tilled throughout a wide range of moisture content.

The soil is used mainly for cultivated crops. It is suited to small grains, corn, and sunflowers. Soil blowing and water erosion are the major concerns in management where cultivated crops are grown. Soil blowing is a severe hazard. Erosion can be controlled by field windbreaks, buffer strips, stripcropping, and conservation tillage that leaves crop residue on the surface. Because of the low available water capacity, droughtiness is a concern in management, especially during extended dry periods. Crop residue on the soil and green-manure crops help conserve moisture.

This soil is suited to the trees and shrubs used as windbreaks or environmental plantings. Because of the low available water capacity of the soil, species that tolerate droughty conditions should be selected. In addition, removing or controlling competing vegetation helps seedling survival and growth.

This soil is suited to use as building sites and poorly suited to use as septic tank absorption fields. It readily absorbs the effluent in a septic tank absorption field but does not adequately filter it. The poor filtering capacity can result in the pollution of ground water. The sides of basements and other shallow excavations tend to cave in unless they are shored.

The land capability classification of this soil is IIIe.

59—Overly silty clay loam, 0 to 3 percent slopes. This is a level and nearly level, deep, moderately well drained soil on glacial lake plains. Individual areas range from 20 to 200 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsoil is silty clay loam about 23 inches thick. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of 60 inches or more is mottled, light olive brown silty clay loam. In places the subsoil has an accumulation of clay. In other places the surface layer is silt loam. In a few places the substratum has lenses of fine sandy loam or loamy sand.

Included with this soil in mapping and making up about 15 to 20 percent of the map unit are small areas of Bearden, Fargo, Hegne, and Perella soils. The Bearden soils are on swells. They are somewhat poorly drained and have a layer of accumulated lime within a depth of 16 inches. The Fargo soils are poorly drained and are in depressions. The Hegne soils are poorly drained and are on swells. Fargo and Hegne soils have a silty clay

surface layer. The Perella soils are in swales and are poorly drained.

The Overly soil is moderately slowly permeable. The available water capacity is high. Runoff is slow. A seasonal high water table fluctuates between depths of 4 and 6 feet. Because the surface layer is silty clay loam, tilth generally is only fair.

This soil is used mainly for cultivated crops. The soil is well suited to sunflowers, corn, small grains, and sugar beets. Soil erosion is the main concern in management where cultivated crops are grown. Erosion can be controlled by buffer strips and conservation tillage that leaves crop residue on the surface. Tilling the soil when it is neither too wet nor too dry helps prevent surface compaction and helps maintain or improve tilth. Returning crop residue to the soil also helps maintain or improve tilth.

The Overly soil is suited to trees and shrubs used as windbreaks or environmental plantings. Grasses and weeds should be removed before trees are planted and should be controlled after a windbreak is established.

This soil is suited to use as building sites and septic tank absorption fields. The shrink-swell potential is a limitation for building sites. Surface and foundation drains and reinforced foundation and basement walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements. The slow absorption of liquid wastes in a septic tank absorption field can be offset by enlarging the absorption field. The seasonal high water table is a continuing limitation for septic tank absorption fields.

The land capability classification of this soil is IIc.

59B—Overly silty clay loam, 3 to 6 percent slopes. This is a gently sloping, deep, moderately well drained soil on low ridges of glacial lake plains. The areas of the soil range from 20 to 200 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsoil is silty clay loam about 23 inches thick. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of 60 inches or more is mottled light olive brown silty clay loam. In places the subsoil has an accumulation of clay. In other places the surface layer is silt loam. In a few places the substratum has lenses of fine sandy loam or loamy sand. In places the surface layer is 4 to 8 inches thick.

Included with this soil in mapping and making up about 15 to 20 percent of the map unit are small areas of Bearden and Perella soils and areas of a well drained soil that has a thin surface layer. The Bearden soils are on swells. They are somewhat poorly drained and have a layer of accumulated lime within a depth of 16 inches. The Perella soils are in swales. They are poorly drained. The well drained soil that has a thin surface layer is on slight knobs or on knolls.

The Overly soil is moderately slowly permeable. The available water capacity is high. Runoff is slow. A seasonal high water table fluctuates between depths of 4 and 6 feet. Because the surface layer is silty clay loam, tilth generally is only fair.

This soil is used mainly for cultivated crops. The soil is well suited to sunflowers, corn, small grains, and sugar beets. Erosion is the main concern in management where cultivated crops are grown. It can be controlled by buffer strips and conservation tillage that leaves crop residue on the surface. Tilling the soil when it is neither too wet nor too dry helps prevent surface compaction and helps maintain or improve tilth. Returning crop residue to the soil also helps maintain or improve soil tilth.

The Overly soil is suited to trees and shrubs used as windbreaks or environmental plantings. Grasses and weeds should be removed before trees are planted and should be controlled after the windbreak is established.

This soil is suited to use as building sites and septic tank absorption fields. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced foundation and basement walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements. The slow absorption of liquid wastes in a septic tank absorption field can be offset by enlarging the absorption field. The seasonal high water table is a continuing limitation for septic tank absorption fields.

The land capability classification of this soil is IIe.

61—Perella-Bearden silty clay loams. This complex consists of level, deep, somewhat poorly drained soils on glacial lake plains. The Perella soil is in swales and depressions. The Bearden soil is on flat and slightly convex swells. The natural drainage pattern is poorly defined. In most areas, excess surface water is removed by a system of constructed drains. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are about 50 percent Perella soil and 30 percent Bearden soil. The areas range from about 30 to 600 acres in size.

Typically, the surface soil of the Perella soil is silty clay loam about 16 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is dark grayish brown silty clay loam about 10 inches thick. The substratum extends to a depth of 60 inches or more. It is mottled olive gray silty clay loam in the upper part and mottled light brownish gray silt loam in the lower part. In places the subsoil has an accumulation of clay. In other places, the surface layer is silt loam. In a few places the substratum contains lenses of fine sandy loam or loamy sand.

Typically, the Bearden soil has a black silty clay loam surface layer about 9 inches thick. The next layer is grayish brown silt loam about 3 inches thick. The subsoil

is light olive brown silt loam about 12 inches thick. The substratum extends to a depth of 60 inches or more. It is light olive brown silt loam in the upper part and grayish brown silty clay loam in the lower part. It is mottled at a depth of 24 inches to a depth of 60 inches. In places the surface layer is loam or silt loam. In other places the soil has more sand throughout than is typical.

Included with these soils in mapping and making up about 20 percent of the map unit are small areas of Colvin and Overly soils. The Colvin soils are in swales. They are poorly drained and have a light brownish gray lower substratum. The Overly soils are on slight ridges. They are moderately well drained and do not have mottles within a depth of 30 inches.

Perella and Bearden soils are moderately slowly permeable. The available water capacity is high. Runoff is slow. A seasonal high water table fluctuates between depths of 2 and 4 feet. Because the surface layer is silty clay loam, tilth generally is only fair.

These soils are used mainly for cultivated crops. They are suited to small grains, corn, sunflowers, soybeans, and sugar beets. The soils are used extensively for sugar beets. A system of constructed drains removes surface water in most areas, thus increasing the suitability of the soils for crops. In undrained areas, the common crops are grown each year, but seeding is delayed by wetness. Keeping the drains open and controlling soil blowing are the main concerns where cultivated crops are grown. The Bearden soil is especially susceptible to soil blowing. Soil blowing can be controlled by the use of stripcropping, buffer strips, windbreaks, and conservation tillage that leaves crop residue on the surface.

These soils are suited to trees and shrubs used as windbreaks or environmental plantings. There are no critical limitations.

The soils are poorly suited to use as septic tank absorption fields and building sites. The slow absorption of liquid waste in a septic tank absorption field can be offset by enlarging the absorption field. The seasonal high water table is a continuing limitation. An alternate system for onsite waste disposal, such as a mound system, can be used in some areas. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drainage also help prevent seepage into basements.

The land capability classification of these soils is IIe.

62—Overly-Bearden silt loams, 0 to 3 percent slopes. This complex consists of level and nearly level, deep soils on glacial lake plains. The moderately well drained, nearly level Overly soil is on ridges. The somewhat poorly drained, level Bearden soil is in swales. The natural drainage pattern is poorly defined. In most areas, excess surface water is removed by a system of constructed drains. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are about 55 percent Overly soil and 30 percent Bearden soil. The areas range from about 30 to 600 acres in size.

Typically, the surface layer of the Overly soil is black silt loam about 8 inches thick. The subsoil is silty clay loam about 23 inches thick. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of 60 inches or more is mottled light olive brown silty clay loam. In places the subsoil has an accumulation of clay. In other places, the surface layer is silty clay loam. In a few places the substratum contains lenses of fine sandy loam or loamy sand.

Typically, the Bearden soil has a black silt loam surface layer about 9 inches thick. The next layer is grayish brown silt loam about 3 inches thick. The subsoil is light olive brown silt loam about 12 inches thick. The substratum extends to a depth of 60 inches or more. It is light olive brown silt loam in the upper part and grayish brown silty clay loam in the lower part. It is mottled between depths of 24 and 60 inches. In places the surface layer is loam or silty clay loam. In other places the soil contains more sand throughout than is typical.

Included with these soils in mapping and making up about 20 percent of the map unit are small areas of Colvin and Perella soils. The Colvin soils are in swales. They are poorly drained and are light brownish gray in the lower part of the substratum. The Perella soils are in swales. They are poorly drained.

Overly and Bearden soils are moderately slowly permeable. The available water capacity is high. Runoff is slow. A seasonal high water table is at a depth of 4 to 6 feet in the Overly soil and at a depth of 2 to 4 feet in the Bearden soil. The surface layer is easily tilled throughout a wide range of moisture content.

These soils are used mainly for cultivated crops. They are suited to small grains, corn, sunflowers, soybeans, and sugar beets. They are used extensively for sugar beets. Surface water is drained artificially on the Bearden soil, thus increasing its suitability for crops. The common crops, however, are grown each year in undrained areas. Drainage and soil blowing are the main concerns in management where cultivated crops are grown. The Bearden soil, in particular, is subject to soil blowing. Soil blowing can be controlled by stripcropping, buffer strips, windbreaks, and conservation tillage that leaves crop residue on the surface.

These soils are suited to trees and shrubs used as windbreaks or environmental plantings. There are no critical limitations.

These soils are poorly suited to use as septic tank absorption fields and building sites. The slow absorption of liquid wastes in a septic tank absorption field can be offset by enlarging the absorption field. The seasonal

high water table is a continuing limitation for septic tank absorption fields. An alternate system for onsite waste disposal, such as a mound system, can be used in some areas. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements.

The land capability classification of these soils is IIc.

63B—Renshaw-Sioux loam, 1 to 6 percent slopes. This complex consists of nearly level and undulating, deep soils on glacial outwash plains. The somewhat excessively drained Renshaw soil is shallow to sand and gravel. It is on side slopes. The excessively drained Sioux soil is very shallow to sand and gravel. It is on knolls and ridges. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are 30 to 55 percent Renshaw soil and 25 to 40 percent Sioux soil. The areas range from about 10 to 70 acres in size.

Typically, the Renshaw soil has a black loam surface layer about 7 inches thick. The subsoil is very dark grayish brown loam about 8 inches thick. The substratum extends to a depth of 60 inches or more. It is dark brown calcareous gravelly loamy sand in the upper part and brown very gravelly loamy sand in the lower part. In some places the depth to gravelly loamy sand is 15 to 40 inches.

Typically, the Sioux soil has a black loam surface layer about 7 inches thick. The next layer is brown gravelly loamy sand about 4 inches thick. The substratum to a depth of 60 inches or more is grayish brown and brown extremely gravelly sand.

Included with these soils in mapping and making up 10 to 25 percent of the map unit are small areas of Embden and Gardena soils. The Embden and Gardena soils are moderately well drained. They are dark colored to a depth of more than 16 inches. Also included are some areas where the slope ranges from 6 to 9 percent.

Renshaw and Sioux soils are rapidly permeable. The available water capacity of the Renshaw soil is low and that of the Sioux soil is very low. Runoff is slow. The surface layer is easily tilled throughout a wide range of moisture content.

These soils are used mainly for cultivated crops. They are poorly suited to small grains, corn, and sunflowers. Water erosion, soil blowing, and the low available water capacity are the main concerns in management where cultivated crops are grown. Conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help control erosion. Returning crop residue to the soil helps maintain or improve tilth.

The Renshaw soil is suited to trees and shrubs used as windbreaks and environmental plantings. It is possible to establish plantings on the Sioux soil, but survival and growth will be less than optimum. Measures that conserve soil moisture help establish seedlings.

These soils are poorly suited to use as septic tank absorption fields. They are suited to use as building sites. The soils readily absorb the effluent in a septic tank absorption field but do not adequately filter it. Consequently, the ground water supply can become polluted. The sides of basements and other shallow excavations tend to cave in unless they are shored.

The land capability classification of these soils is IVe.

63C—Sioux gravelly sandy loam, 3 to 9 percent slopes. This is a gently sloping and moderately sloping, deep, excessively drained soil on ridges and knobs on glacial outwash plains and moraines. It is very shallow over sand and gravel. Individual areas range from about 5 to more than 60 acres in size.

Typically, the surface layer is black gravelly sandy loam about 7 inches thick. The next layer is brown gravelly loamy sand about 4 inches thick. The substratum to a depth of 60 inches or more is grayish brown and brown extremely gravelly sand. In some places the surface layer is loam or sandy loam.

Included with this soil in mapping and making up about 5 to 15 percent of the map unit are small areas of Embden and Renshaw soils. The Embden soils have a fine sandy loam surface soil and subsoil, and the Renshaw soils have a loam surface layer and subsoil. Both Embden and Renshaw soils are lower on the landscape than the Sioux soil.

The Sioux soil is rapidly permeable. The available water capacity is very low. Runoff is slow.

This soil is used mainly for pasture or wildlife habitat, but in some areas it is used for cultivated crops. The soil is best suited to rangeland or pasture. It generally is not suited to crops, trees, and shrubs because of droughtiness. The use of this soil as pasture or range effectively controls erosion. The key native plants to manage are needleandthread and blue grama. Overgrazing promotes the growth of less desirable plants and increases the risk of erosion. A system of grazing—alternate and deferred—that leaves about 50 percent of the annual growth of the key plants helps protect the soil and maintains the range in good condition.

This soil is suited to use as building sites and poorly suited to use as septic tank absorption fields. The soil readily absorbs the effluent in a septic tank absorption field but does not adequately filter it. Consequently, the ground water supply can become polluted. The sides of basements or other shallow excavations tend to cave in unless they are shored.

The land capability classification of this soil is VIs.

64—Pits, gravel. This map unit consists of areas from which the soil material and the underlying sand and gravel have been removed. Many of the areas are abandoned and are idle, and most support little or no

vegetation. The areas range from about 3 to more than 25 acres in size.

Most areas are not suited to agricultural use unless they are leveled, topdressed with suitable soil material, and otherwise reclaimed. The areas, however, without reclamation can be planted to climatically adapted trees and shrubs that provide habitat for wildlife. The suitable species varies from pit to pit.

Most areas are not suitable as sites for septic tank absorption fields or buildings unless the areas are leveled and reclaimed. Onsite investigation is needed to determine the suitability for these uses. Drainage outlets are needed in ponded areas where a seasonal high water table is evident.

A capability class or subclass was not assigned.

65—Svea-Barnes loams, 0 to 2 percent slopes. This complex consists of level and nearly level, deep soils on glacial till plains. The moderately well drained Svea soil is on foot slopes. The well drained Barnes soil is on side slopes. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are 50 to 60 percent Svea soil and 30 percent Barnes soil. The areas range from about 5 to 1,200 acres in size.

Typically, the Svea soil has a black loam surface soil about 18 inches thick. The subsoil is loam about 25 inches thick. It is very dark gray in the upper part and light yellowish brown in the lower part. The substratum to a depth of 60 inches or more is light olive brown loam. It is mottled at a depth of 48 inches to a depth of 60 inches.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 7 inches thick. It is very dark grayish brown in the upper part and grayish brown in the lower part. The next layer, which extends to a depth of 22 inches, is light yellowish brown loam. The substratum to a depth of 60 inches or more is loam. In some places the surface layer and substratum are sandy loam or fine sandy loam. In places the surface layer is light brownish gray and eroded.

Included with these soils in mapping and making up 10 to 20 percent of the map unit are small areas of Hamerly and Tonka soils. The Hamerly soils are somewhat poorly drained and are on toe slopes. They have a layer of accumulated lime within a depth of 16 inches. The Tonka soils are poorly drained and are in depressions. They have a light colored subsurface layer.

Svea and Barnes soils are moderately slowly permeable. The available water capacity is high. Runoff is slow on the Svea soil and medium on the Barnes soil. A seasonal high water table fluctuates between depths of 4 and 6 feet in the Svea soil. The surface layer is easily tilled throughout a wide range of moisture content.

These soils are used mainly for cultivated crops. The soils are suited to small grains and sunflowers. Soil blowing and water erosion are the main concerns in management where cultivated crops are grown. Field windbreaks, stripcropping, cover crops, and buffer strips help reduce soil blowing. Conservation tillage, which leaves crop residue on the surface over winter, helps control soil blowing and erosion on fields that are tilled in the fall. Grassed waterways and diversions help to control erosion caused by runoff. Returning crop residue to the soil helps increase the infiltration rate and reduces runoff.

These soils are suited to trees and shrubs used as windbreaks or environmental plantings. No critical limitations affect trees and shrubs.

The soils are suited to use as septic tank absorption fields and building sites. The slow absorption of liquid wastes in a septic tank absorption field can be offset by enlarging the absorption field. The seasonal high water table of the Svea soil is a continuing limitation for septic tank absorption fields. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements on the Svea soil.

The land capability classification of these soils is IIc.

66—Wyard-Hamerly loams, 1 to 3 percent slopes. This complex consists of nearly level, deep, somewhat poorly drained soils on glacial till plains. The Wyard soil is on toe slopes and in slight depressions below the Hamerly soil. The Hamerly soil is on low knolls. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are 40 to 60 percent Wyard soil and 30 to 35 percent Hamerly soil (fig. 12). The areas range from about 5 to 150 acres in size.

Typically, the Wyard soil has a black loam surface soil about 10 inches thick. The subsoil is mottled loam about 18 inches thick. It is very dark grayish brown in the upper part and light brownish gray in the lower part. The substratum to a depth of 60 inches or more is mottled loam. It is pale olive in the upper part and olive brown in the lower part. In some areas the soil is moderately well drained.

Typically, the Hamerly soil has a black loam surface soil about 10 inches thick. The subsoil is grayish brown loam about 14 inches thick. The substratum to a depth of 60 inches or more is loam. It is olive in the upper part and mottled light olive brown in the lower part. In some areas, generally the higher lying slopes, the calcareous layer is more than 16 inches below the surface. In other areas, generally the lower lying areas, the substratum is grayish brown in the lower part.

Included with these soils in mapping and making up 5 to 20 percent of the map unit are small areas of poorly drained Tonka soils. Tonka soils are in depressions and have a light colored subsurface layer.

Figure 12.—An area of Wyard-Hamerly loams, 1 to 3 percent slopes. These soils were mapped together because they are so intricately mixed. When it is dry, the Hamerly soil is light colored because of its high content of lime.

The Wyard soil is moderately permeable, and the Hamerly soil is moderately slowly permeable. The available water capacity is high. Runoff is slow. A seasonal high water table is at a depth of 1 to 3 feet in the Wyard soil and at a depth of 2 to 4 feet in the Hamerly soil. The surface layer is easily tilled throughout a wide range of moisture content.

These soils are used mainly for cultivated crops. They are suited to small grains and sunflowers. Generally, they are best suited to late seeded crops. Wetness is the main concern where cultivated crops are grown. Drainage increases the suitability of the soils for crops, but outlets for surface drains generally are difficult to locate. In cultivated areas, the soils are susceptible to soil blowing. On the Hamerly soil, soil blowing is a moderate hazard. Field windbreaks, stripcropping, buffer strips, and conservation tillage that leaves crop residue on the surface help reduce soil blowing.

These soils are suited to trees and shrubs used as windbreaks or environmental plantings. Measures to control soil blowing help to minimize abrasion of seedlings.

The soils are poorly suited to use as septic tank absorption fields and building sites. Wetness is the main limitation. A drainage system and diversions for surface runoff help reduce wetness on building sites, but the seasonal high water table is a continuing limitation for septic tank absorption fields. The slow absorption of liquid wastes in a septic tank absorption field can be offset by enlarging the absorption field. The shrink-swell potential is a limitation on building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling.

The land capability classification of these soils is IIw.

67—Galchutt fine sandy loam. This is a level, deep, somewhat poorly drained soil in swales of glacial lake plains. The natural drainage pattern is poorly defined. Excess surface water is removed in most areas by artificial drainage. The areas of this soil range from 20 to about 500 acres in size.

Typically, the surface soil is fine sandy loam about 17 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The subsurface layer is mottled dark brown very fine sandy loam about 10 inches thick. The subsoil is mottled olive gray silty clay about 6 inches thick. The substratum to a depth of 60 inches or more is mottled olive gray silty clay.

Included with this soil in mapping and making up about 15 to 25 percent of the map unit are small areas of Bearden, Gardena, and Tiffany soils. The Bearden soils are on swells. They have a layer of accumulated lime within a depth of 16 inches. The Gardena soils are on low ridges and swells. They have a silt loam subsoil and substratum. The Tiffany soils are poorly drained and are in swales. They have a surface layer of silt loam or loam.

The Galchutt soil is slowly permeable. The available water capacity is high. Runoff is very slow. A seasonal high water table fluctuates between depths of 1 and 3 feet. The surface layer is easily tilled throughout a wide range of moisture content.

This soil is used mainly for cultivated crops. The soil is well suited to small grains, corn, sunflowers, soybeans, and sugar beets. Artificial drainage removes surface water in most areas, thus increasing the suitability of the soil for crops. In undrained areas, wetness is a moderate limitation. Soil blowing is a concern where the soil is drained and cultivated crops are grown. Soil blowing can be controlled by buffer strips and conservation tillage that leaves crop residue on the surface.

The Galchutt soil is suited to trees and shrubs used as windbreaks or environmental plantings. Grasses and weeds should be removed before trees are planted, and they should be controlled after a windbreak is established.

The soil is poorly suited to use as building sites, and generally it is not suited to septic tank absorption fields because of slow permeability, high clay content, and wetness. Alternate systems of waste disposal, such as a holding tank or a mound system constructed on the surface, should be considered. The shrink-swell potential is a limitation for building sites. Surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements.

The land capability classification of this soil is IIIe.

71—Vallers loam. This is a level, deep, poorly drained soil on the rim of depressions on glacial till plains. Excess water from spring runoff and from heavy rains ponds on this soil for short periods. Individual areas range from about 5 to 50 acres in size.

Typically, the Vallers soil has a black loam surface layer about 7 inches thick. The next layer is very dark grayish brown and very dark gray loam about 4 inches thick. The subsoil is dark gray loam about 7 inches thick. The substratum to a depth of 60 inches or more is olive gray clay loam. It is mottled at a depth of 28 inches to a depth of 60 inches. In some places the surface layer is silt loam or silty clay loam.

Included with this soil in mapping and making up about 10 to 25 percent of the map unit are small areas of Hamerly, Parnell, and Tonka soils and saline Vallers soil. The Hamerly soils are higher on the landscape than Vallers loam. They are somewhat poorly drained. The lower part of their substratum is olive and light olive brown. The Parnell soils are very poorly drained. They are in depressions. They have a subsoil of accumulated clay. The poorly drained Tonka soils are in shallow depressions. They have a light colored subsurface layer.

The Vallers soil is moderately slowly permeable. The available water capacity is high. Runoff is very slow. A seasonal high water table fluctuates between depths of 1 and 2.5 feet. The surface layer is easily tilled throughout a wide range of moisture content.

This soil is used mainly for cultivated crops. The soil is poorly suited to small grains and sunflowers. Wetness and soil blowing are the main concerns in management where cultivated crops are grown. Adequate outlets for drainage generally are difficult to locate. Surface drains help reduce the wetness; however, increased salinity has been observed in some drained areas. Soil blowing is a moderate hazard. Annual buffer strips and conservation tillage that leaves crop residue on the surface help reduce soil blowing.

If drained, this soil is suited to trees and shrubs used as windbreaks and environmental plantings. If the soil is not drained, generally it is too wet for this use. Measures that control soil blowing help protect seedlings from abrasion.

This soil generally is not suited to use as septic tank absorption fields or building sites because of wetness. Soils suited to these uses generally are nearby.

The land capability classification of this soil is IIw.

72—Wahpeton silty clay. This is a level, deep, moderately well drained soil on flood plains and low terraces. This soil is occasionally flooded. Individual areas range from about 5 to 40 acres in size.

Typically, the surface soil is very dark gray silty clay about 33 inches thick. The substratum to a depth of 60 inches or more is silty clay. It is dark grayish brown and very dark grayish brown in the upper part and dark olive gray in the lower part.

Included with this soil in mapping and making up about 10 to 20 percent of the map unit are small areas of Cashel, Fargo, and Nutley soils. The Cashel soils are on flood plains. They are somewhat poorly drained and have a stratified surface layer. The Fargo soils are on glacial lake plains adjacent to the Wahpeton soil. They are poorly drained. The Nutley soils are gently sloping and moderately sloping. They also are on glacial lake plains.

The Wahpeton soil is moderately slowly permeable. The available water capacity is high. Runoff is slow. Because the surface layer is silty clay, tilth generally is poor.

This soil is used mainly for cultivated crops. It is suited to small grains, soybeans, corn, and sunflowers. Tilling the soil when it is neither too wet nor too dry helps prevent surface compaction and improves tilth. Returning crop residue to the soil helps maintain or improve tilth. Soil blowing, which is a moderate hazard, can be controlled by annual buffer strips and conservation tillage that leaves crop residue on the surface.

This soil is suited to trees and shrubs used as windbreaks or environmental plantings. Grasses and weeds should be removed before trees are planted and should be controlled after a windbreak is established.

The soil generally is not suited to use as building sites or septic tank absorption fields because of flooding. Sites that are not subject to flooding generally are nearby.

The land capability classification of this soil is IIs.

73—Rauville silty clay loam. This is a level, deep, very poorly drained soil on flood plains and in seepy areas. The soil is frequently flooded. The landscape generally is dissected by meandering channels into small, irregularly shaped areas. Many areas are isolated by deep channels or steep escarpments. Individual areas of this soil range from 10 to about 100 acres in size.

Typically, the surface soil is black silty clay loam about 32 inches thick. The substratum extends to a depth of 60 inches or more. It is mottled gray silty clay loam in the upper part and mottled olive gray stratified sand, gravel, and clay loam in the lower part. In places, the soil is poorly drained. In some areas, the surface soil is thinner than is typical and a calcareous layer is within 16 inches of the surface. In other areas, the surface soil is silt loam. In some areas, there is about 3 inches of partly decomposed organic material on the surface.

Included with this soil in mapping and making up 10 to 15 percent of the map unit are small areas of Colvin and Lamoure soils. Colvin soils are moderately saline and are poorly drained. Lamoure soils are poorly drained. They are on the higher parts of the flood plains.

The Rauville soil is moderately slowly permeable. The available water capacity is high. Runoff is very slow. A seasonal high water table fluctuates between the surface and 2 feet below the surface.

This soil is idle or is used for habitat for wetland wildlife. This soil is best suited to that use. This soil generally is not suited to crops, hay, trees, and shrubs because of excessive wetness.

This soil generally is not suited to use as septic tank absorption fields or building sites because of flooding and wetness, and generally it is not used for these purposes in the survey area. Soils that are suited generally are nearby.

The land capability classification of this soil is Vw.

76—Wyndmere silt loam, 0 to 3 percent slopes. This is a level and nearly level, deep, somewhat poorly drained soil on swells of glacial lake plains. The natural drainage pattern is poorly defined. Excess surface water is removed in most areas by artificial drainage. The areas of this soil range from about 20 to 180 acres in size.

Typically, the surface soil is silt loam about 14 inches thick. It is very dark gray in the upper part and very dark grayish brown in the lower part. The subsoil is mottled grayish brown fine sandy loam. The substratum to a depth of 60 inches or more is fine sandy loam. It is mottled dark yellowish brown in the upper part and multicolored in the lower part. In places the surface layer is loam.

Included with this soil in mapping and making up about 5 to 20 percent of the map unit are small areas of Gardena, Glyndon, and Tiffany soils. The Gardena soils are moderately well drained and are on ridges. The Glyndon soils are somewhat poorly drained and are on swells. They have more silt and less sand than the Wyndmere soil. The Tiffany soils are in depressions.

The Wyndmere soil is moderately rapidly permeable. The available water capacity is high. Runoff is slow. A seasonal high water table fluctuates between depths of 2 and 5 feet. The surface layer is easily tilled throughout a wide range of moisture content.

The soil is used mainly for cultivated crops. It is suited to small grains, corn, sunflowers, soybeans, and sugar beets. A system of constructed drains removes surface water in most areas, thus increasing the suitability of the soil for crops. Without the drainage system, the common crops are grown each year, but seeding is sometimes delayed. Soil blowing is a moderate hazard. It can be controlled by the use of stripcropping, buffer strips, windbreaks, and conservation tillage that leaves crop residue on the surface.

This soil is suited to trees and shrubs used as windbreaks or environmental plantings. Measures that control soil blowing help protect seedlings from abrasion.

This soil is poorly suited to use as septic tank absorption fields or building sites because of the seasonal high water table. Surface and foundation drains help prevent seepage into basements. The sides of basements and other shallow excavations tend to cave in unless they are shored.

The land capability classification of this soil is IIe.

76B—Wyndmere silt loam, undulating. This is a gently sloping, deep, somewhat poorly drained soil on swells on glacial lake plains. The slope ranges from 3 to 6 percent. The areas of this soil are crossed by many meandering abandoned channels that range in depth from a few inches to 1 or 2 feet. Individual areas of this soil range from about 20 to 180 acres in size.

Typically, the surface soil is silt loam about 14 inches thick. It is very dark gray in the upper part and very dark grayish brown in the lower part. The subsoil is mottled grayish brown fine sandy loam. The substratum to a depth of 60 inches or more is fine sandy loam. It is mottled dark yellowish brown in the upper part and multicolored in the lower part. In some places the surface layer is loam or silty clay loam.

Included with this soil in mapping and making up about 5 to 20 percent of the map unit are small areas of Gardena, Glyndon, and Tiffany soils. Gardena soils are moderately well drained. They are on ridges. Glyndon soils are somewhat poorly drained. They have more silt and less sand than the Wyndmere soil. Tiffany soils are poorly drained. They are in depressions.

The Wyndmere soil is moderately rapidly permeable. The available water capacity is high. Runoff is slow. A seasonal high water table fluctuates between depths of 2 and 5 feet. The surface layer is easily tilled throughout a wide range of moisture content.

This soil is used mainly for cultivated crops. The soil is suited to small grains, corn, and sunflowers. Soil blowing and water erosion are concerns in management where cultivated crops are grown. Soil blowing is a moderate hazard. Annual buffer strips and conservation tillage that leaves crop residue on the surface help control soil blowing and erosion.

The Wyndmere soil is suited to trees and shrubs in windbreaks and environmental plantings. Measures that control soil blowing help protect seedlings from abrasion.

This soil is poorly suited to use as septic tank absorption fields and building sites because of the seasonal high water table. Surface and foundation drains help prevent seepage into basements. The sides of basements and other shallow excavations tend to cave in unless they are shored.

The land capability classification of this soil is IIe.

77—Vallers loam, saline. This is a level, deep, poorly drained, moderately saline soil on the rims of depressions on glacial till plains. Excess water from spring runoff and heavy rains ponds on this soil for short periods. Individual areas of this soil range from about 5 to 50 acres in size.

Typically, the surface layer is black loam about 7 inches thick. It contains white flecks of salt. The next layer is very dark grayish brown and very dark gray loam about 4 inches thick. The subsoil is dark gray loam about 7 inches thick. The substratum to a depth of about 60 inches is olive gray clay loam. It is mottled at a depth of 28 inches to a depth of 60 inches. In some places the surface layer is silt loam or silty clay loam.

Included with this soil in mapping and making up from 10 to 25 percent of the map unit are small areas of Tonka and Parnell soils and of nonsaline Hamerly and Vallers soils. The Hamerly soils are higher on the landscape than the saline Vallers soil. They are somewhat poorly drained and are olive and light olive brown in the lower part of the substratum. Tonka soils are poorly drained. They are in shallow depressions. They have a light colored subsurface layer. The Parnell soils are very poorly drained. They are in deeper depressions. They have a subsoil layer of accumulated clay.

The Vallers soil is moderately slowly permeable. The available water capacity is moderate. Runoff is very slow. A seasonal high water table fluctuates between the surface and 1 foot below the surface. The high salt content of this soil restricts plant growth. The surface layer is easily tilled throughout a wide range of moisture content.

This soil is used mainly for cultivated crops. The soil is poorly suited to small grains and sunflowers. Wetness, salinity, and soil blowing are the main concerns in management where cultivated crops are grown. Adequate outlets for drainage often are difficult to locate, but artificial drainage helps reduce wetness. Planting salt-tolerant crops, avoiding summer fallow, and avoiding deep tillage help reduce the salinity problem. Increased salinity has been observed in some drained areas. Soil blowing is a moderate hazard. Annual buffer strips and crop residue on the surface help reduce soil blowing.

This Vallers soil is suited to trees or shrubs used as windbreaks and environmental plantings; however, only the most salt-tolerant species should be selected for planting. The seedling mortality rate is high, and the vigor, density, and height of surviving trees and shrubs are severely restricted.

This soil generally is not suited to use as septic tank absorption fields or building sites because of wetness, and generally this soil is not used as building sites or septic tank absorption fields. Soils that are better suited generally are nearby.

The land capability classification of this soil is IIIs.

78B—Svea-Buse loams, 3 to 6 percent slopes. This complex consists of undulating, deep soils on glacial till plains. The moderately well drained Svea soil is on foot slopes. The well drained Buse soil is on knolls. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are 50 to 60 percent Svea soil and 30 percent Buse soil. The areas range from about 5 to 1,200 acres in size.

Typically, the Svea soil has a black loam surface soil about 18 inches thick. The subsoil is loam about 25 inches thick. It is very dark gray in the upper part and light yellowish brown in the lower part. The substratum to a depth of 60 inches or more is light olive brown loam. It is mottled at a depth of 48 inches to a depth of 60 inches.

Typically, the Buse soil has a very dark gray loam surface layer about 7 inches thick. The next layer is very dark grayish brown calcareous loam about 3 inches thick. The subsoil is grayish brown loam about 9 inches thick. The substratum to a depth of 60 inches or more is light olive brown loam. In some places the surface layer and substratum are sandy loam or fine sandy loam. In places the surface soil is light brownish gray and is eroded.

Included with these soils in mapping and making up 10 to 20 percent of the map unit are small areas of Barnes, Hamerly, and Tonka soils. The Barnes soils are well drained and are on side slopes. The Hamerly soils are somewhat poorly drained and are on toe slopes. They have a layer of accumulated lime within a depth of 16 inches. The Tonka soils are poorly drained and have a

surface layer that is light in color. They are in depressions.

Svea and Buse soils are moderately slowly permeable. Their available water capacity is high. Runoff is slow on the Svea soil and medium on the Buse soil. A seasonal high water table fluctuates between depths of 4 and 6 feet in the Svea soil. The surface layer of both soils is easily tilled throughout a wide range of moisture content.

These soils are used mainly for cultivated crops. These soils are suited to small grains and sunflowers. Soil blowing, particularly on the Buse soil, and erosion are the main concerns in management where cultivated crops are grown. Field windbreaks, stripcropping, cover crops, and buffer strips help reduce soil blowing (fig. 13). Conservation tillage, which leaves crop residue on the surface over winter, helps control soil blowing and erosion on fields that are tilled in the fall. Grassed waterways and diversions help control erosion where runoff concentrates. Returning crop residue to the soil helps increase the infiltration rate and helps reduce runoff.

The soils are suited to trees and shrubs used as windbreaks or environmental plantings. It is possible to establish plantings on the Buse soil, but survival, growth, and vigor will not be optimum. The Svea soil has no

Figure 13.—In this area of Svea-Buse loams, 3 to 6 percent slopes, flax buffer strips help protect the soil from soil blowing and help keep snow uniformly distributed on the field. The flax is planted late in the growing season.

limitations for trees and shrubs. Measures that control soil blowing help protect the seedlings from abrasion.

The soils are suited to use as septic tank absorption fields and building sites. The slow absorption of liquid wastes in a septic tank absorption field can be offset by enlarging the absorption field. The seasonal high water table of the Svea soil is a continuing limitation for septic tank absorption fields. The shrink-swell potential is a limitation to use of the soils as sites for buildings, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements in the Svea soil.

The land capability classification of these soils is IIe.

80—Wyndmere-Tiffany loams, 0 to 3 percent slopes. This complex consists of deep soils on glacial lake plains and glacial outwash plains. The Wyndmere soil is somewhat poorly drained. It is level and nearly level and is on swells. The Tiffany soil is poorly drained. It is level and is in depressions. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are 50 to 60 percent Wyndmere soil and 30 to 35 percent Tiffany soil. The areas range from about 20 to 180 acres in size.

Typically, the Wyndmere soil has a loam surface soil about 14 inches thick. It is very dark gray in the upper part and very dark grayish brown in the lower part. The subsoil is mottled grayish brown fine sandy loam. The substratum to a depth of 60 inches or more is fine sandy loam. It is mottled dark yellowish brown in the upper part and multicolored in the lower part. In some places the silt and clay content are higher than is typical.

Typically, the Tiffany soil has a surface soil of black loam about 13 inches thick. The next layer is mottled dark grayish brown fine sandy loam about 9 inches thick. The substratum is mottled light olive brown very fine sandy loam in the upper part; it is mottled light brownish gray silt loam to a depth of 60 inches or more. In some places this soil has a higher content of silt and clay than is typical.

Included with these soils in mapping and making up 5 to 20 percent of the map unit are small areas of Divide, Gardena, and Glyndon soils. The Divide soils are somewhat poorly drained and are on toe slopes. The Gardena soils are moderately well drained and are on swells. The Glyndon soils are somewhat poorly drained and also are on swells. Gardena and Glyndon soils have more silt and less sand than the Wyndmere and Tiffany soils.

The Wyndmere soil is moderately rapidly permeable, and the Tiffany soil is moderately permeable. The available water capacity is high. Runoff is slow on the Wyndmere soil and ponded on the Tiffany soil. A seasonal high water table is at a depth of 2 to 5 feet in the Wyndmere soil and between 1 foot above the surface and 3 feet below the surface in the Tiffany soil. The surface layer is easily tilled throughout a wide range of moisture content.

These soils are used mainly for cultivated crops. They are suited to small grains, corn, soybeans, and sunflowers. Excess water is removed in most areas by artificial drainage. Where cultivated crops are grown, the main concerns in management are wetness and soil blowing. Soil blowing is a moderate hazard on the Wyndmere soil. Conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help control erosion.

The Wyndmere soil is suited to trees and shrubs used as windbreaks and environmental plantings. If it is not drained, the Tiffany soil generally is not suited. Measures that control soil blowing help protect seedlings from abrasion.

The Wyndmere soil is poorly suited to use as septic tank absorption fields and building sites, and the Tiffany soil generally is not suited. Surface drains help remove excess water. In the Tiffany soil, the moderate absorption of liquid wastes in a septic tank absorption field can be offset by enlarging the absorption field. Wetness is a limitation to use of Wyndmere and Tiffany soils as absorption fields. Surface and foundation drains help prevent seepage into basements. The sides of basements and other shallow excavations tend to cave in unless they are shored.

The land capability classification of these soils is IIe.

82—Glyndon-Tiffany silt loams, 0 to 3 percent slopes. This complex consists of deep soils on glacial lake plains and glacial outwash plains. The Glyndon soil is somewhat poorly drained. It is a level and nearly level soil on swells. The Tiffany soil is poorly drained. It is a level soil in depressions. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are 50 to 60 percent Glyndon soil and 30 to 35 percent Tiffany soil. The areas range from about 10 to 200 acres in size.

Typically, the Glyndon soil has a black silt loam surface soil about 12 inches thick. The subsoil is mottled silt loam about 16 inches thick. It is dark grayish brown in the upper part and olive brown in the lower part. The substratum to a depth of 60 inches or more is light olive brown and is mottled. It is very fine sandy loam in the upper part and stratified silt loam in the lower part. In some places the silt and clay content are higher than is typical.

Typically, the Tiffany soil has a surface soil of black silt loam about 13 inches thick. The next layer is mottled dark grayish brown fine sandy loam about 9 inches thick. The substratum is mottled light olive brown very fine sandy loam in the upper part; it is mottled light brownish gray silt loam to a depth of 60 inches or more. In some

places this soil has a higher content of silt and clay than is typical.

Included with these soils in mapping and making up about 5 to 20 percent of the map unit are small areas of Gardena and Wyndmere soils. The Gardena soils are moderately well drained and are on slight ridges. The Wyndmere soils are somewhat poorly drained and have more sand and less silt than the Glyndon soil.

The Glyndon soil is moderately rapidly permeable, and the Tiffany soil is moderately permeable. The available water capacity is high. Runoff is slow on the Glyndon soil and ponded on the Tiffany soil. A seasonal high water table is at a depth of 2.5 to 6 feet in the Glyndon soil and between 1 foot above the surface and 3 feet below the surface in the Tiffany soil. The surface layer of both soils is easily tilled throughout a wide range of moisture content.

These soils are used mainly for cultivated crops. These soils are suited to small grains, corn, soybeans, and sunflowers. A system of constructed drains removes excess water in most areas. Where cultivated crops are grown, the main concerns in management are wetness and soil blowing. Soil blowing is a moderate hazard on the Glyndon soil. Conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help control erosion.

The Glyndon soil is suited to trees and shrubs used as windbreaks and environmental plantings. Unless it is drained, the Tiffany soil generally is not suited. Measures that control soil blowing help protect seedlings from abrasion.

The Glyndon soil is poorly suited to use as septic tank absorption fields and building sites. The Tiffany soil generally is not suited. Surface drains help remove excess water, but the seasonal high water table is a continuing limitation for absorption fields. Surface and foundation drains help prevent seepage into basements. The sides of basements and other shallow excavations tend to cave in unless they are shored.

The land capability classification of these soils is IIe.

83—Galchutt-Fargo silty clay loams. This complex consists of level, deep soils on glacial lake plains. The Galchutt soil is somewhat poorly drained. It is on swells. The Fargo soil is poorly drained. It is in swales. The natural drainage pattern is poorly defined. Excess surface water is removed by a system of constructed drains. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are about 50 percent Galchutt soil and 30 percent Fargo soil. The areas range from about 40 to 350 acres in size.

Typically, the Galchutt soil has a surface soil about 17 inches thick. It is black silty clay loam in the upper part and very dark gray loam in the lower part. The subsurface layer is mottled dark grayish brown very fine sandy loam about 8 inches thick. The subsoil is mottled olive gray silty clay about 6 inches thick. The substratum to a depth of 60 inches or more is mottled olive gray silty clay. In places the surface layer is silt loam.

Typically, the Fargo soil has a black silty clay loam surface layer about 10 inches thick. The subsoil is silty clay about 12 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The next layer is dark grayish brown silty clay about 8 inches thick. The substratum to a depth of 60 inches or more is olive gray silty clay. It is mottled at a depth of 45 inches to a depth of 60 inches. In places the surface layer is as much as 24 inches thick.

Included with these soils in mapping and making up about 20 percent of the map unit are small areas of Gardena and Tiffany soils. The Gardena soils are on low ridges. They are moderately well drained. The Tiffany soils are in slight depressions. They are poorly drained.

Galchutt and Fargo soils are slowly permeable. Their available water capacity is high. Runoff is very slow. A seasonal high water table is at a depth of 1 to 3 feet in the Galchutt soil and at the surface or within 3 feet of the surface in the Fargo soil. Because the surface layer is silty clay loam, tilth generally is only fair.

These soils are used mainly for cultivated crops. The soils are suited to small grains, sugar beets, sunflowers, and soybeans (fig. 14). A system of constructed drains removes surface water in most areas. Without the drainage system, seeding is delayed or sometimes prevented by wetness. Soil blowing is a slight hazard. It can be controlled by stripcropping, buffer strips, windbreaks, and conservation tillage that leaves crop residue on the surface.

The Galchutt soil is suited to trees and shrubs used as windbreaks or environmental plantings. Unless it is drained, the Fargo soil generally is not suited.

These soils are poorly suited to use as building sites and generally are not suited to septic tank absorption fields because of slow permeability and clay content. Alternate systems of waste disposal, such as a holding tank or a mound system constructed on the surface, should be considered. The shrink-swell potential is a limitation for building sites. Surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. Surface and foundation drains also help prevent seepage into basements.

The land capability classification of these soils is IIw.

84—Bearden-Lindaas silty clay loams. This complex consists of level, deep soils on glacial lake plains. The Bearden soil is somewhat poorly drained. It is on swells. The Lindaas soil is poorly drained. It is in swales. The natural drainage pattern is poorly defined. Excess surface water is removed in most areas by a system of constructed drains. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately. The mapped areas are about 50

Figure 14.—Barley commonly is grown on Galchutt-Fargo silty clay loams. Swathing helps obtain uniform drying of the grain, and the stubble left on the surface over winter helps prevent soil blowing.

percent Bearden soil and 30 percent Lindaas soil. The areas range from about 30 to 600 acres in size.

Typically, the surface layer of the Bearden soil is black silty clay loam about 9 inches thick. The next layer is grayish brown silt loam about 3 inches thick. The subsoil is light olive brown silt loam about 12 inches thick. The substratum is mottled, light olive brown silt loam in the upper part; it is grayish brown silty clay loam to a depth of 60 inches or more. In places the surface layer is loam or silt loam. In other places the soil contains more sand throughout than is typical.

Typically, the surface soil of the Lindaas soil is black silty clay loam about 11 inches thick. The subsoil is about 25 inches thick. It is very dark gray silty clay in the upper part, very dark grayish brown silty clay in the next part, and mottled grayish brown silt loam in the lower part. The substratum is mottled, light brownish gray silty clay loam in the upper part; to a depth of 60 inches or more, it is light brownish gray and light yellowish brown very fine sandy loam, silt loam, and silty clay loam in alternating layers. In places the subsoil does not have an accumulation of clay. In other places, the surface layer is silt loam.

Included with these soils in mapping and making up about 20 percent of the map unit are small areas of Fargo, Overly, and Perella soils. The Fargo soils are in swales and slight depressions. They are poorly drained. The Overly soils are on slight ridges. They are moderately well drained. The Perella soils are in the lower part of swales. They are somewhat poorly drained.

The Bearden soil is moderately slowly permeable, and the Lindaas soil is slowly permeable. The available water capacity of both soils is high. Runoff is slow on the Bearden soil and ponded on the Lindaas soil. A seasonal high water table is at a depth of 2 to 4 feet in the Bearden soil and between 1 foot above the surface

and 2 feet below the surface in the Lindaas soil. Because the surface layer is silty clay loam, soil tilth generally is only fair.

These soils are used mainly for cultivated crops. These soils are suited to small grains, corn, sunflowers, soybeans, and sugar beets. In most areas of the Lindaas soil, a system of constructed drains removes surface water, thus increasing the suitability of the soil for crops. Without the drainage system, seeding is delayed or sometimes prevented by wetness. Yearly maintenance of the drainage system is required to keep the drains open. The Bearden soil can be tilled and planted at the normal time without a drainage system. Soil blowing is a moderate hazard on these soils. It can be controlled by stripcropping, buffer strips, windbreaks, and conservation tillage that leaves crop residue on the surface.

The Bearden soil is suited to trees and shrubs used as windbreaks or environmental plantings. Unless it is drained, the Lindaas soil generally is not suited because of wetness. Measures that control soil blowing help to protect seedlings from abrasion.

The Bearden soil is poorly suited to use as septic tank absorption fields or as building sites, and the Lindaas soil generally is not suited. Ponding of the Lindaas soil is the major limitation. Surface drains help remove excess surface water. The slow absorption of liquid wastes in a septic tank absorption field can be offset by enlarging the absorption field. The seasonal high water table is a continuing limitation. An alternate system for onsite waste disposal, such as a mound system, can be used in some areas. The shrink-swell potential is a limitation for building sites, but surface and foundation drains and reinforced basement and foundation walls help prevent the structural damage caused by shrinking and swelling. The surface and foundation drainage also help prevent seepage into basements.

The land capability classification of these soils is IIe.

85—Fairdale Variant silt loam. This is a level, deep, moderately well drained soil on flood plain splays. This soil is rarely flooded. The areas range from 15 acres to 100 acres in size.

Typically, the surface layer is very dark brown silt loam about 9 inches thick. The substratum in sequence downward to a depth of 60 inches or more is dark grayish brown stratified loam, black silty clay, and very dark gray silty clay. In some places the surface layer is fine sandy loam or loam.

Included with this soil in mapping and making up about 15 to 25 percent of the map unit are small areas of Fairdale and LaDelle soils. The Fairdale soils have a silt loam, loam, or fine sandy loam substratum. The LaDelle soils are on flood plains and on low stream terraces. They have a silty clay loam surface layer.

The Fairdale Variant soil is slowly permeable. The available water capacity is high. Runoff is slow. A seasonal high water table fluctuates between depths of 2 and 4 feet. The surface layer is easily tilled throughout a wide range of moisture content.

This soil is used mainly for cultivated crops. A few areas are wooded and are used as pasture. The soil is suited to small grains, corn, sunflowers, soybeans, and sugar beets. The main concerns in management are erosion and soil blowing. Erosion can be controlled by buffer strips and conservation tillage that leaves crop residue on the surface.

This soil is suited to trees and shrubs used as windbreaks or environmental plantings. Grasses and weeds should be removed before trees are planted and should be controlled after a windbreak is established.

This soil is suited to use as pasture, and this use is effective in controlling erosion. The key native plants to manage are western wheatgrass and green needlegrass. Prolonged overgrazing of the key plants will decrease production, promote the growth of less desirable plants, and increase the risk of erosion. A system of grazing—alternate or deferred—that leaves about 50 percent of the annual growth of the key plants helps protect the soil and helps maintain the pasture in good condition.

This soil generally is not suited to use as septic tank absorption fields because of flooding, wetness, slow permeability, and high clay content. It generally is not suited to use as building sites because of the flooding hazard. Better sites that are not subject to flooding generally are nearby.

The land capability classification of this soil is IIc.

Prime Farmland

In this section, prime farmland is defined and discussed, and the prime farmland soils in the Cass County Area are listed.

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the nation's short- and long-range needs for food and fiber. The acreage of high-quality farmland is limited, and the U.S. Department of Agriculture recognizes that government at local, state, and federal levels, as well as individuals, must encourage and facilitate the wise use of our nation's prime farmland.

Prime farmland soils, as defined by the U.S. Department of Agriculture, are soils that are best suited to producing food, feed, forage, fiber, and oilseed crops. Such soils have properties that are favorable for the economic production of sustained high yields of crops. The soils need only to be treated and managed using acceptable farming methods. The moisture supply, of course, must be adequate, and the growing season has to be sufficiently long. Prime farmland soils produce the highest yields with minimal inputs of energy and economic resources, and farming these soils results in the least damage to the environment.

Prime farmland soils may presently be in use as cropland, pasture, or woodland, or they may be in other uses. They either are used for producing food or fiber or are available for these uses. Urban or built-up land and water areas cannot be considered prime farmland.

Prime farmland soils usually get an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The acidity or alkalinity level of the soils is acceptable. The soils have few or no rocks and are permeable to water and air. They are not excessively erodible or saturated with water for long periods and are not subject to frequent flooding during the growing season. The slope ranges mainly from 0 to 6 percent.

Soils that have a high water table, are subject to flooding, or are droughty may qualify as prime farmland soils if the limitations or hazards are overcome by drainage, flood control, or irrigation. Onsite evaluation is necessary to determine the effectiveness of corrective measures. More information on the criteria for prime farmland soils can be obtained at the local office of the Soil Conservation Service.

About 645,000 acres in the Cass County Area, or nearly 70.5 percent of the area, meets the requirements for prime farmland.

A recent trend in land use in some parts of the county has been the conversion of some prime farmland to urban and industrial uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are wet, more erodible, droughty, or difficult to cultivate and less productive than prime farmland.

The following map units, or soils, make up prime farmland in the Cass County Area. If a soil is considered to be prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name. The location of each map unit is shown on the detailed soil maps at the back of this publication. The extent of each unit is given in table 4. The soil qualities that affect use and management are described in the section "Detailed Soil Map Units." This list does not constitute a recommendation for a particular land use.

1	Fargo-Enloe silty clays (where drained)
2	Tonka silt loam (where drained)
4	Perella silty clay loam (where drained)
5	Dovray silty clay (where drained)
12	Hegne-Enloe silty clays (where drained)
14B	Barnes-Buse loams, 3 to 6 percent slopes
15	Emrick-Heimdal loams, 1 to 3 percent slopes
15B	Heimdal-Emrick loams, 3 to 6 percent slopes
17B	Barnes-Svea loams, 2 to 5 percent slopes
18	Bearden silty clay loam
22	Bearden-Perella silty clay loams
24	Cashel silty clay
26	Colvin silty clay loam (where drained)
27	Divide loam
31B	Embden fine sandy loam, gravelly substratum, 1 to 6 percent slopes
32	Fargo silty clay, 1 to 3 percent slopes (where drained)
35	Fairdale silt loam, 1 to 3 percent slopes
36	Fargo silty clay (where drained)
37	Fargo silty clay, depressional (where drained)
38	Fargo silty clay loam (where drained)
39	Galchutt silt loam (where drained)
40	Fargo-Hegne silty clays (where drained)
41	Hegne-Fargo silty clay loams (where drained)
43	Gardena silt loam
46	Gardena-Glyndon silt loams, 0 to 3 percent slopes
47	Fargo silty clay, smooth surface (where drained)

48 Glyndon silt loam, 0 to 3 percent slopes
50 Hamerly-Tonka loams, 0 to 3 percent slopes (where drained)
50B Hamerly loam, 3 to 6 percent slopes
54 Lamoure silty clay loam (where drained)
55 LaDelle silty clay loam
59 Overly silty clay loam, 0 to 3 percent slopes
59B Overly silty clay loam, 3 to 6 percent slopes
61 Perella-Bearden silty clay loams
62 Overly-Bearden silt loams, 0 to 3 percent slopes
65 Svea-Barnes loams, 0 to 2 percent slopes
66 Wyard-Hamerly loams, 1 to 3 percent slopes (where drained)
67 Galchutt fine sandy loam (where drained)
71 Vallers loam (where drained)
72 Wahpeton silty clay
76 Wyndmere silt loam, 0 to 3 percent slopes
76B Wyndmere silt loam, undulating
78B Svea-Buse loams, 3 to 6 percent slopes
80 Wyndmere-Tiffany loams, 0 to 3 percent slopes (where drained)
82 Glyndon-Tiffany silt loams, 0 to 3 percent slopes (where drained)
83 Galchutt-Fargo silty clay loams (where drained)
84 Bearden-Lindaas silty clay loams (where drained)
85 Fairdale Variant silt loam

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Lyle Samson, agronomist, Soil Conservation Service, prepared this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

More than 90 percent of Cass County is cultivated. In 1979, according to a statistics report for Cass County, 488,900 acres in the county was in close-grown crops; 445,300 acres in row crops; 29,800 acres in forage crops; and 39,000 acres in summerfallow *(12)*. In 1980, 635,300 acres was in close-grown crops; 350,800 acres in row crops; 27,000 acres in forage crops; and 2,000 acres in summerfallow *(11)*. The variation in the yearly acreage of row crops and close-grown crops is the result of market prices and climatic conditions. Yearly variations are normal.

In 1980, the acreage in the principal close-grown crops was as follows—360,000 acres in spring wheat; 67,000 acres in durum; 2,500 acres in winter wheat; 176,000 acres in barley; 12,500 acres in oats; 9,500 acres in rye; and 8,800 acres in flax. The acreage in row crops was 185,000 acres in sunflowers; 53,000 acres in corn for grain; 6,000 acres in corn for silage; 68,700 acres in soybeans; 18,000 acres in dry edible beans; and 20,000 acres in sugar beets (fig. 15). The acreage in forage crops was 19,000 acres in alfalfa and 8,000 acres in other hay crops. In addition, small acreages were planted to rapeseed, mustard, buckwheat, lentils, potatoes, sorghum, millet, and bird seed.

In the last 10 years there has been a marked increase in the production of sunflowers, corn for grain, soybeans, and dry edible beans.

The potential of the soils for increased yield of food and fiber is good. Production is steadily increasing as the latest crop-production technology is applied.

The soils and climate of the county are suited to most of the crops that commonly are grown in the area and to some crops not commonly grown, for example, melons, cabbages, sweet corn, and squash.

Controlling soil blowing and water erosion, removing excess water, conserving moisture, and maintaining fertility and tilth are the principal concerns in management (fig. 16).

Figure 15.—Sugar beets are grown on about 20,000 acres in the county. This is an area of Perella-Bearden silty clay loams. Soil blowing can be a problem in winter and in spring because sugar beets are a low-residue crop.

Soil blowing and water erosion reduce the productivity of the soils. If the surface layer is lost, available plant nutrients also are lost. Additions of fertilizer are then needed to maintain profitable levels of crop production.

Figure 16.—Including alfalfa or other legumes in the cropping system helps protect this Fargo soil from erosion.

The added cost reduces the net return from the land.

Soil blowing is a hazard on most of the soils in the Cass County Area. The hazard is severe on coarse and moderately coarse textured soils, such as Embden and Maddock soils, and on fine textured soils, such as Fargo and Hegne soils, when climatic conditions cause surface granulation. Most soils are susceptible to damage by soil blowing if there is no ground cover.

Water erosion is a severe hazard on moderately sloping and steeply sloping soils, such as the Barnes and Buse soils, 6 to 35 percent slopes. It is a moderate hazard on gently sloping soils, such as the Barnes and Svea soils, 2 to 5 percent slopes. Soils are most susceptible to water erosion if the surface is bare and unprotected.

Soil blowing and water erosion can be controlled by crop residue on the surface, conservation tillage, cover crops, stripcropping, buffer strips, field windbreaks and diversions, grassed waterways, and grasses and legumes in the crop rotation (fig. 16). A combination of several of these measures is usually needed to control erosion effectively.

Another major concern in management is the loss of organic matter that is caused by erosion. The loss of organic matter adversely affects soil structure, water infiltration, available moisture capacity, and soil tilth.

Excess surface water collects on many soils in spring and during periods of heavy rainfall. Draining poorly drained and very poorly drained soils generally increases yields and the variety of crops that are suited to a particular soil. Artificial drainage and road ditches help

remove excess surface water in many areas of Dovray, Fargo, Hegne, Parnell, Perella, and Tonka soils (fig. 17).

Measures that conserve moisture are necessary on soils, such as the Maddock and Renshaw soils, that tend to be droughty. Decreasing evaporation and runoff and increasing the infiltration rate are major concerns in management. Stubble mulch, conservation tillage, no-till, grasses and legumes in the crop rotation, field windbreaks, buffer strips, stripcropping, cover crops, and crop residue on the soil are effective ways to conserve moisture. If fallow is practiced, it is important to provide ground cover over winter to prevent moisture loss and erosion.

Measures that improve fertility are needed on some soils. Commercial fertilizers, green-manure crops, legumes in the cropping system (fig. 18), and barnyard manure help to improve fertility.

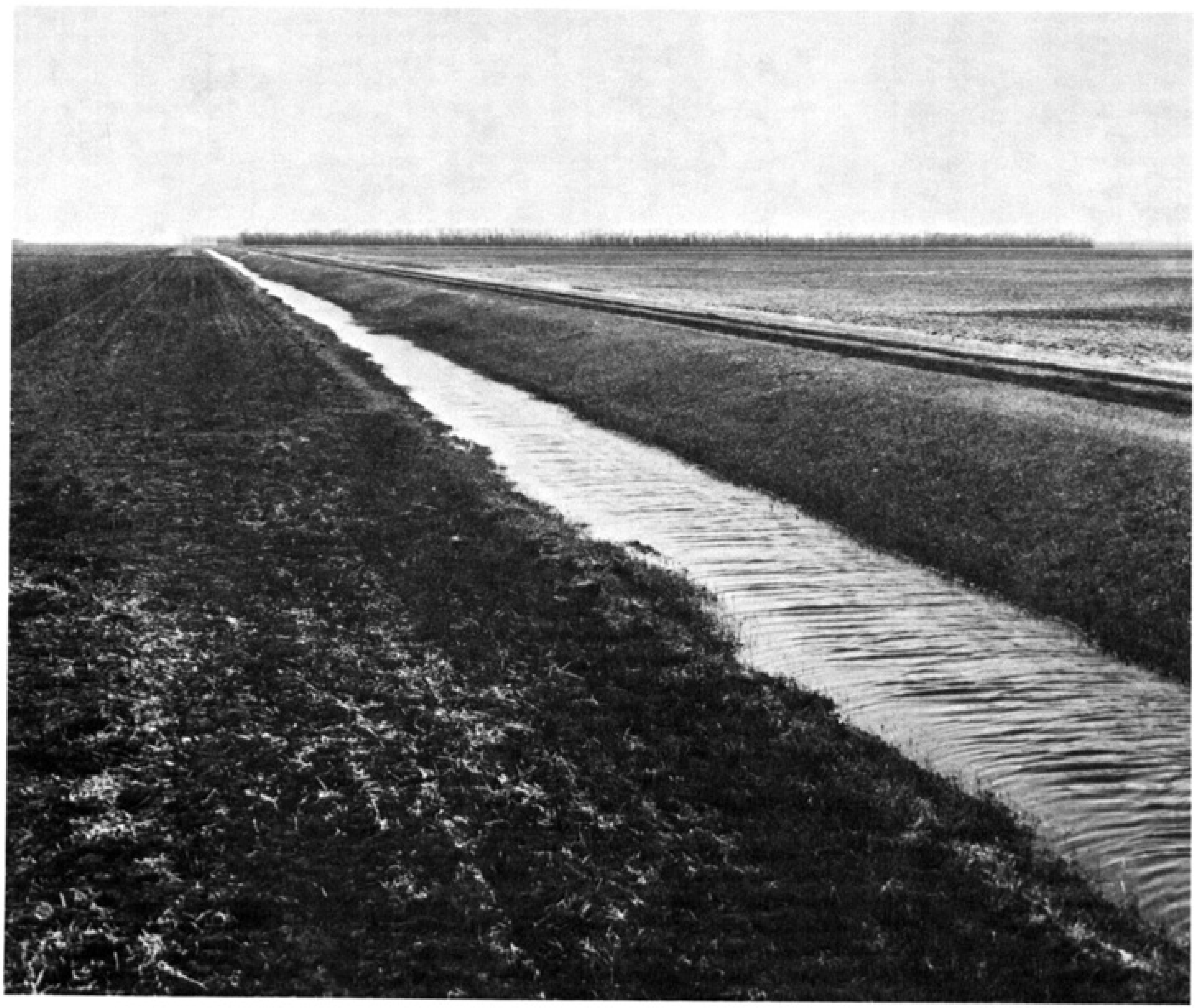

Figure 17.—A road ditch drains this area of Fargo and Hegne soils. The soils of the lacustrine plain generally are poorly drained or very poorly drained.

Figure 18.—Sweetclover is plowed under on these Perella-Bearden soils to help improve tilth and fertility and to increase the content of organic matter.

Proper management of soils includes provisions for maintaining good tilth. The silty clay loams and silty clays, for example, Bearden, Fargo, Hegne, and Dovray soils, require special attention. A traditional practice has been fall plowing to secure maximum freeze-thaw effect through late in the fall, winter, and early in spring. A serious drawback to this technique is the hazard of erosion associated with bare soil. Experience has shown that fall plowing can result in the loss of soil and the deposition of wind-blown sediment on machinery and in buildings, waterways, and channels (fig. 19). Furthermore, wind removes the fertilizer and pesticides that are applied in the fall. Soil blowing also contributes to air pollution. Concerned farmers are developing ways other than fall plowing, therefore, to maintain tilth. Some of the ways are fall chiseling in lieu of plowing, leaving crop residue on the soil over winter, and using cover crops, annual barriers, field shelterbelts, stripcropping, and minimum or no-till farming.

Some stone removal is required on soils that formed in glacial till. Barnes, Buse, and Hamerly soils are examples.

Further information about the management of crops can be obtained from local offices of the Soil Conservation Service and the Cooperative Extension Service.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management

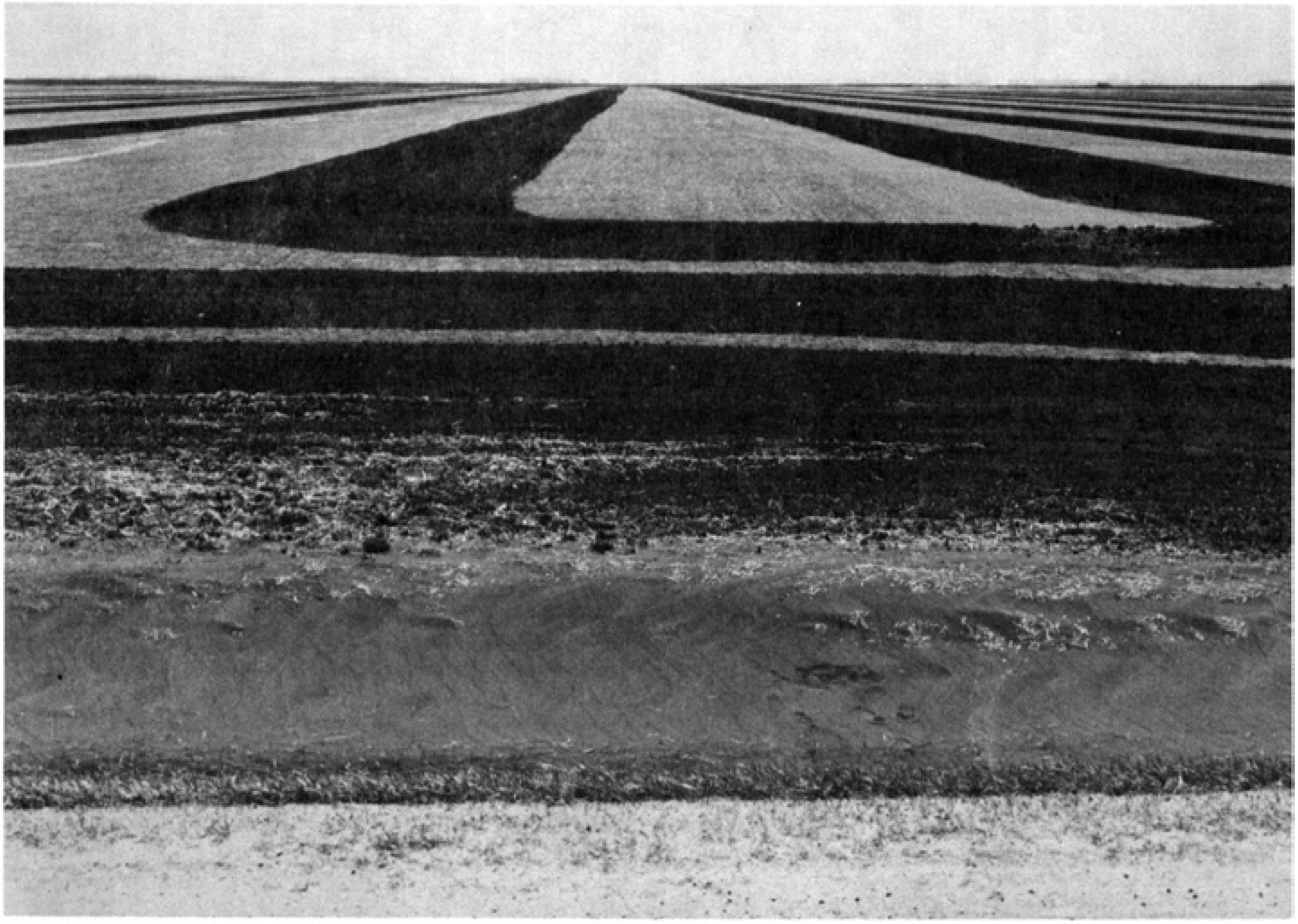

Figure 19.—Emergency tillage (dark strips) on this Fargo soil helps control soil blowing. Drifting soil has partly blocked the drainage channel in the foreground.

are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information

about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c,* used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

Capability units are soil groups within a subclass. The soils in a capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-4 or IIIe-6.

The capability class and subclass of each map unit are given in the section "Detailed Soil Map Units."

Woodland, Windbreaks, and Environmental Plantings

Elmer R. Umland, forester, Soil Conservation Service, prepared this section.

Cass County has approximately 12,700 acres of native woodland. Early settlers used the trees for lumber, fenceposts, and fuel. The trees and shrubs are mainly on the Cashel, LaDelle, and Wahpeton soils on the flood plain of the Red, Wild Rice, and Elm Rivers, and on the Fairdale soils along the Maple, Sheyenne, and Rush Rivers.

The principal species of trees and shrubs in the county are American elm, green ash, boxelder, American basswood, bur oak, eastern cottonwood, common chokecherry, American plum, silver buffaloberry, redosier dogwood, golden currant, Woods rose, and various willows and hawthorns. Green ash and bur oak dominate the side slopes and breaks of the valleys; eastern cottonwood, American elm, and boxelder are the most common species on the flood plains.

The first settlers in the Cass County Area planted windbreaks to protect their farmsteads and feedlots. In the late 1930's approximately 3,500 acres of trees and shrubs were planted in the county under the Prairie States Forestry Project of the U.S. Department of Agriculture's Forest Service. Since that time, more than 6 million trees and shrubs have been planted on more than 8,000 acres by county farmers. Tree plantings are still needed around many farmsteads. Windbreaks are particularly needed in cultivated areas because soil blowing is a serious hazard.

The following factors should be considered before planting a windbreak—purpose of the planting, suitability of the soils, adaptability of the various species of trees and shrubs, location and design of the windbreak, and a source from which to obtain the selected trees and shrubs.

The establishment of a windbreak or an environmental planting and the subsequent growth of the trees and shrubs depend on suitable preparation of the site and proper maintenance after the trees and shrubs are planted. Grasses and weeds must be eliminated before planting; therefore, regrowth of the grasses and weeds must be controlled. Some replanting of the seedlings is likely while the young trees are becoming established.

Windbreaks protect livestock, buildings, roads, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 6 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 6 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

Erling B. Podoll, biologist, Soil Conservation Service, prepared this section.

Recreation areas have been developed throughout the survey area. There are facilities, mainly in Fargo, for swimming, skating, golf, and other sports. There are hiking trails and areas for camping and picnicking.

Public lands are not available for outdoor activities such as cross-country skiing or snowmobiling. There are, however, 3,100 acres of waterfowl areas and 1,100 acres of wildlife areas that are used for hiking and bird watching.

Northern pike and channel catfish can be fished in the Red River, the Sheyenne River, and the Maple River. Brewer Lake, a 128-acre impoundment, is a managed rainbow trout and walleyed pike fishery. The potential for developing new fishing waters or for improving the existing ones is poor.

The soils of the survey area are rated in table 7 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 7, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 7 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 10 and interpretations for dwellings without basements and for local roads and streets in table 9.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have gentle slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are

not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

Erling B. Podoll, biologist, Soil Conservation Service, prepared this section.

Birds and mammals that inhabit the Cass County Area include gray partridge, pheasant, mourning dove, waterfowl, fox squirrel, white-tailed deer, red fox, raccoon, mink, badger, striped skunk, white-tailed jackrabbit, beaver, and muskrat. About 200 additional species may be observed in the county at various times of the year.

There is a fair distribution of diverse habitat in the western part of the survey area. Wetlands and riparian stream woodlands provide the major part of the important habitat.

About 26,000 acres of habitat for wetland wildlife remain in the survey area. About 90 percent of this acreage, most of which is tilled, is temporary habitat. There are about 12,700 acres of native woodland that is used as wildlife habitat.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 8, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, wheatgrass, bromegrass, sweetclover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are little and big bluestem, goldenrod, green needlegrass, western wheatgrass, and blue grama.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are juneberry, dogwood, hawthorn, and snowberry.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce

grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include deer, meadowlark, and lark bunting.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 9 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic

layers can cause the movement of footings. A high water table, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Sanitary Facilities

Table 10 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 10 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, and flooding affect absorption of the effluent. Large stones interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 10 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 10 are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 11 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 11, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 12 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by toxic substances in the root zone, such as salts or sodium. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, and large stones affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, and slope affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 16.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 13 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 16.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

Physical and Chemical Properties

Table 14 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Soil and Water Features

Table 15 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission. The dual symbol C/D indicates the drained and undrained soil condition.

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 15 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 15 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 15.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high

the water rises above the surface. The second numeral indicates the depth below the surface.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, and moisture content of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture and amount of sulfates in the saturation extract.

Engineering Index Test Data

Table 16 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the North Dakota State Highway Department Laboratory.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(16)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 17 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Boroll (*Bor*, meaning cool, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haploborolls (*Hapl*, meaning minimal horizonation, plus *boroll*, the suborder of the Mollisols that have a frigid temperature regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Udic* identifies the subgroup that has a Udic (usually moist) moisture regime. An example is Udic Haploborolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed Udic Haploborolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series. An example is the Barnes series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual (15)*. Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (16)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Barnes Series

The Barnes series consists of deep, well drained, moderately slowly permeable soils on glacial till plains. The soils formed in medium textured or moderately fine textured glacial till. The slope ranges from 0 to 25 percent.

Barnes soils are similar to Heimdal soils and commonly are adjacent to Buse, Hamerly, and Heimdal soils. The Buse soils are calcareous at the surface and do not have a Bw horizon. The Hamerly soils have a layer of accumulated lime within a depth of 16 inches. They are somewhat poorly drained. The Heimdal soils

have less clay than the Barnes soils. The Buse soils are higher on the landscape than Barnes soils, and the Hamerly soils are lower.

Typical pedon of Barnes loam, in an area of Barnes-Svea loams, 2 to 5 percent slopes, 100 feet north and 200 feet west of the southeast corner of sec. 22, T. 141 N., R. 54 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to weak medium and coarse granular; hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; few fine and many very fine pores; neutral; abrupt smooth boundary.

Bw—7 to 11 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak coarse subangular blocky structure parting to weak fine subangular blocky; hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; few medium and many very fine pores; 5 percent coarse fragments; neutral; clear wavy boundary.

Bk—11 to 14 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure parting to weak fine subangular blocky; hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; common very fine pores; 5 percent coarse fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

BCk—14 to 22 inches; light yellowish brown (2.5Y 6/4) loam, pale yellow (2.5Y 7/4) dry; weak coarse subangular blocky structure parting to weak fine subangular blocky; hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine pores; 5 percent coarse fragments; many gypsum crystals; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C—22 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; few fine distinct dark brown (7.5YR 4/4) mottles; massive; hard, friable, slightly sticky and slightly plastic; common very fine pores; 10 percent coarse fragments; strong effervescence; moderately alkaline.

The solum ranges from 10 to 23 inches in thickness, and the mollic epipedon ranges from 7 to 16 inches. The B horizon is loam or clay loam. The BCk horizon also is loam or clay loam. The C horizon has few to many mottles and is loam or clay loam.

Bearden Series

The Bearden series consists of deep, somewhat poorly drained, moderately slowly permeable soils on glacial lake plains. The soils formed in medium textured and moderately fine textured lacustrine sediment. The slope is 0 to 1 percent.

Bearden soils are similar to Glyndon and Hamerly soils and commonly are adjacent to Fargo, Lindaas, Overly, and Perella soils. Fargo soils are poorly drained, have less silt and more clay than the Bearden soils, and do not have a layer of accumulated lime within a depth of 16 inches. Glyndon soils have less clay than the Bearden soils. Hamerly soils have less silt and more sand than the Bearden soils. Lindaas soils are poorly drained and have an argillic horizon. Overly soils do not have a layer of accumulated lime within a depth of 16 inches. They have a mollic epipedon that is more than 16 inches thick. Perella soils are poorly drained. Fargo, Lindaas, and Perella soils are lower on the landscape than Bearden soils, and Overly soils are higher.

Typical pedon of Bearden silty clay loam, in an area of Bearden-Lindaas silty clay loams, 1,900 feet south and 280 feet east of the northwest corner of sec. 30, T. 141 N., R. 50 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate coarse granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and common fine roots; many very fine and common fine pores; lime disseminated throughout; slight effervescence; mildly alkaline; abrupt smooth boundary.

ABk—9 to 12 inches; grayish brown (10YR 5/2) silt loam, light brownish gray (10YR 6/2) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine and few fine pores; lime disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary.

Bk—12 to 24 inches; light olive brown (2.5Y 5/4) silt loam, light yellowish brown (2.5Y 6/4) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; few very fine pores; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—24 to 31 inches; light olive brown (2.5Y 5/4) silt loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct dark grayish brown (10YR 4/2) mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine pores; lime disseminated throughout; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—31 to 36 inches; light olive brown (2.5Y 5/4) silt loam, light yellowish brown (2.5Y 6/4) dry; common medium prominent yellowish red (5YR 4/6) mottles; moderate coarse prismatic structure parting to

moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; lime disseminated throughout; strong effervescence; moderately alkaline; clear wavy boundary.

C3—36 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam, light brownish olive (2.5Y 6/2) dry; few fine distinct dark grayish brown (10YR 4/2) and common fine prominent yellowish red (5YR 4/6) mottles; massive; hard, very friable, slightly sticky and slightly plastic; few very fine roots; laminated; lime disseminated throughout; slight effervescence; moderately alkaline.

The mollic epipedon ranges from 7 to 20 inches in thickness. The soil is saline in some pedons.

The Ap horizon is silt loam or silty clay loam. In places, tongues of A horizon material extend into the Bk horizon. Some pedons do not have an ABk horizon. The Bk horizon is silt loam or silty clay loam. In some pedons the Bk horizon has a few faint mottles. The C horizon has few to many faint to prominent mottles. In some pedons there is sand, clay, or clay loam at a depth of 40 inches or more.

Buse Series

The Buse series consists of deep, well drained, moderately slowly permeable soils on glacial till plains. The soils formed in medium textured or moderately fine textured glacial till. The slope ranges from 3 to 35 percent.

The Buse soils are similar to the Esmond soils and commonly are adjacent to Barnes, Hamerly, and Svea soils. The Barnes soils have a Bw horizon. The Esmond soils have less clay than the Buse soils. The Hamerly soils are somewhat poorly drained and have a layer of accumulated lime within a depth of 16 inches. The Svea soils have a mollic epipedon that is more than 16 inches thick. Barnes, Hamerly, and Svea soils are in landscape positions below those of the Buse soils.

Typical pedon of Buse loam, in an area of Buse-Barnes loams, 15 to 35 percent slopes, 50 feet north and 100 feet east of the southwest corner of sec. 9, T. 139 N., R. 55 W.

A—0 to 7 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common medium, fine and very fine roots; common very fine pores; 5 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

AB—7 to 10 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak coarse subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common very fine roots; common very fine pores; 5 percent coarse fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

Bk—10 to 19 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; weak coarse and medium subangular blocky structure parting to weak fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine pores; 5 percent coarse fragments; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—19 to 33 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; few medium distinct yellowish brown (10YR 5/6) mottles; weak coarse and medium subangular blocky structure parting to weak fine subangular blocky; hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine pores; 5 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—33 to 46 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; few medium distinct yellowish brown (10YR 5/6) mottles; massive; hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine pores; 5 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

C3—46 to 60 inches; light olive brown (2.5Y 5/4) and light yellowish brown (2.5Y 6/4) loam, yellow (2.5Y 7/6) dry; few medium distinct gray (N 6/0) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; 5 percent coarse fragments; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 10 inches thick. Some pedons do not have an AB horizon. The Bk horizon is loam or clay loam. The C horizon is loam or clay loam.

Cashel Series

The Cashel series consists of deep, somewhat poorly drained, moderately slowly permeable soils on flood plains. The soils formed in fine textured alluvium. The slope is 0 to 1 percent.

Cashel soils are similar to Fairdale soils and commonly are adjacent to Fairdale, Fargo, Hegne, and Wahpeton soils. Fairdale soils have more sand and silt than the Cashel soils. Fargo soils are in swales. They have a Bw horizon. Hegne soils are on swells and have a layer of accumulated lime within 16 inches. Wahpeton soils are on levees of streams and have a mollic epipedon that is more than 24 inches thick.

Typical pedon of Cashel silty clay, 1,430 feet south and 3,400 feet east of the northwest corner of sec. 12, T. 141 N., R. 49 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate fine granular structure;

hard, friable, sticky and plastic; common medium and coarse and few fine roots; common medium and few fine and coarse pores; many worm casts; slight effervescence; mildly alkaline; abrupt smooth boundary.

C1—7 to 10 inches; very dark grayish brown (2.5Y 3/2) stratified silty clay, grayish brown (2.5Y 5/2) dry; weak fine angular blocky structure; hard, friable, sticky and plastic; many medium and coarse and few fine roots; many medium and few fine and coarse pores; few fragments of snail shells; many worm casts; slight effervescence; mildly alkaline; abrupt smooth boundary.

Ab1—10 to 25 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; weak fine granular structure; hard, friable, sticky and plastic; common very fine, fine and medium roots; common fine and medium pores and few coarse pores; few fragments of shells; many worm casts; slight effervescence; mildly alkaline; gradual smooth boundary.

C2—25 to 29 inches; very dark gray (5Y 3/1) silty clay, gray (5Y 5/1) dry; massive; hard, friable, sticky and plastic; common very fine, fine, and medium roots; common very fine and fine and few medium pores; few fragments of shells; slight effervescence; mildly alkaline; abrupt smooth boundary.

Ab2—29 to 32 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; massive; hard, friable, sticky and plastic; few very fine, fine, and medium roots; few very fine and fine pores; few fragments of shells; slight effervescence; mildly alkaline; abrupt smooth boundary.

C3—32 to 42 inches; very dark gray (5Y 3/1) silty clay, dark gray (5Y 4/1) and gray (5Y 5/1) dry; massive; hard, friable, sticky and plastic; few very fine, fine and medium roots; few very fine and fine pores; few shell fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Ab3—42 to 46 inches; dark gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; massive; hard, friable, sticky and plastic; few very fine and fine roots; few very fine and fine pores; very few shell fragments; strong effervescence; moderately alkaline; clear smooth boundary.

C4—46 to 53 inches; dark gray (5Y 4/1) silty clay, gray (5Y 5/1) dry; massive; hard, friable, sticky and plastic; few very fine and fine roots; few very fine and fine pores; strong effervescence; moderately alkaline; clear smooth boundary.

C5—53 to 60 inches; gray (5Y 5/1) silty clay, gray (5Y 6/1) dry; massive; hard, friable, sticky and plastic; few very fine and fine roots; few very fine and fine pores; few shell fragments; laminated; strong effervescence; moderately alkaline.

The A horizon is stratified in uncultivated areas. The C horizon is silty clay or clay. In some pedons the soils do not have a buried surface horizon.

Colvin Series

The Colvin series consists of deep, poorly drained, moderately slowly permeable soils on glacial lake plains and in outwash channels. The soils formed in medium textured and moderately fine textured lacustrine sediment and in alluvium. The slope is 0 to 1 percent.

The Colvin soils are similar to Hegne, Perella, and Vallers soils and commonly are adjacent to Lamoure, Perella, and Rauville soils. The Hegne soils have more clay than the Colvin soils. The Perella soils do not have a layer of accumulated lime within a depth of 16 inches. The Vallers soils have more sand and less silt than the Colvin soils. Lamoure and Rauville soils have a mollic epipedon that is more than 24 inches thick. They are on flood plains.

Typical pedon of Colvin silty clay loam, 2,340 feet north and 2,120 feet west of the southeast corner of sec. 8, T. 141 N., R. 50 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine roots; common fine pores; strong effervescence; moderately alkaline; abrupt smooth boundary.

ABk—8 to 13 inches; dark gray (10YR 4/1) silty clay loam, gray (10YR 5/1) dry; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; few fine roots; common fine pores; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk1—13 to 18 inches; gray (2.5Y 6/1) silty clay loam, light gray (2.5Y 7/1) dry; weak coarse subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; common fine pores; lime disseminated throughout; violent effervescence; strongly alkaline; gradual wavy boundary.

Bk2—18 to 36 inches; light brownish gray (2.5Y 6/2) silty clay loam, light gray (2.5Y 7/2) dry; common fine prominent strong brown (7.5YR 5/8) and yellowish red (5YR 5/8) mottles; weak medium subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; common fine pores; lime disseminated throughout; violent effervescence; strongly alkaline; gradual wavy boundary.

Cg—36 to 60 inches; light brownish gray (2.5Y 6/2) stratified silt loam and silty clay loam, light gray (2.5Y 7/2) dry; many medium prominent yellowish red (5YR 5/6) and reddish yellow (7.5YR 6/8) mottles; massive; slightly hard, friable, sticky and

plastic; few fine pores; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 7 to 24 inches in thickness. Colvin soils are saline in some places. The C horizon in some pedons has visible gypsum crystals.

Divide Series

The Divide series consists of deep, somewhat poorly drained soils that are moderately permeable in the upper part and very rapidly permeable in the lower part. They are on glacial outwash plains and between beach ridges. The soils formed in medium textured material overlying coarse textured glacial outwash sediment. The slope is 0 to 1 percent.

Divide soils commonly are adjacent to Embden and Renshaw soils. The Embden soils are moderately well drained. They have a mollic epipedon that is more than 16 inches thick. The Renshaw soils are well drained and are on knobs. Embden and Renshaw soils are in higher positions on the landscape than the Divide soils.

Typical pedon of Divide loam, 2,000 feet north and 300 feet east of the southwest corner, sec. 15, T. 139 N., R. 55 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure parting to moderate fine granular; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine roots; common fine pores; 5 percent coarse fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

A—6 to 14 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine and many very fine roots; common fine pores; 5 percent coarse fragments; strong effervescence; mildly alkaline; clear irregular boundary.

Bk1—14 to 19 inches; gray (2.5Y 5/1) loam, light gray (2.5Y 6/1) dry; weak coarse prismatic structure parting to weak medium subangular blocky; hard, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine pores; 5 percent coarse fragments; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk2—19 to 25 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; weak coarse prismatic structure parting to weak medium subangular blocky; hard, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine pores; 5 percent coarse fragments; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C—25 to 30 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine pores; 10 percent coarse fragments; strong effervescence; moderately alkaline; clear wavy boundary.

2C—30 to 60 inches; olive (5Y 5/3) stratified sand and gravel, pale olive (5Y 6/3) dry; single grained; loose, nonsticky and nonplastic; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 7 to 20 inches in thickness. The depth to sand and gravel ranges from 20 to 40 inches. The soils in some pedons have an AB horizon. The Bk horizon is loam or clay loam.

Dovray Series

The Dovray series consists of deep, very poorly drained, slowly permeable soils on glacial lake plains. The soils formed in fine textured lacustrine sediment. The slope is 0 to 1 percent.

The Dovray soils commonly are adjacent to Cashel, Enloe, Fargo, Hegne, Ryan, and Wahpeton soils. The Cashel soils are stratified immediately below the surface layer. They are on flood plains. The Enloe soils have an albic horizon and, like the Dovray soils, are in depressions. The Fargo soils have a mollic epipedon that is less than 24 inches thick. They are in higher positions on the landscape than the Dovray soils. The Hegne soils have a layer of accumulated lime within a depth of 16 inches. They are on swells. The Ryan soils have salts near the surface, have a natric horizon, and are above the Dovray soils. The Wahpeton soils are moderately well drained and are on stream levees.

Typical pedon of Dovray silty clay, 480 feet south and 1,980 feet west of the northeast corner sec. 11, T. 138 N., R. 49 W.

Ap—0 to 8 inches; black (N 2/0) silty clay, very dark gray (N 3/0) dry; moderate fine granular structure; very hard, firm, sticky and very plastic; common fine roots; common fine pores; neutral; abrupt smooth boundary.

A—8 to 25 inches; black (N 2/0) silty clay, very dark gray (N 3/0) dry; moderate very fine angular blocky structure; very hard, firm, very sticky and very plastic; common fine and very fine roots; common fine pores; neutral; clear irregular boundary.

Bg1—25 to 38 inches; very dark gray (5Y 3/1) clay, dark gray (5Y 4/1) dry; moderate fine angular blocky structure; very hard, very firm, very sticky and very plastic; few very fine roots; few very fine pores; slight effervescence; mildly alkaline; gradual wavy boundary.

Bg2—38 to 57 inches; dark gray (5Y 4/1) clay, gray (5Y 5/1) dry; moderate fine angular blocky structure;

very hard, very firm, very sticky and very plastic; few very fine roots; few very fine pores; slight effervescence; mildly alkaline; gradual wavy boundary.

Cg—57 to 60 inches; dark gray (5Y 4/1) and olive gray (5Y 4/2) clay, gray (5Y 5/1) and olive gray (5Y 5/2) dry; common fine prominent dark yellowish brown (10YR 4/6) mottles; massive; very hard, firm, very sticky and very plastic; slight effervescence; mildly alkaline.

The solum is 28 to 60 inches thick. The mollic epipedon is 24 to 54 inches thick. Some pedons have an 0 horizon that is 0 to 4 inches thick. Cracks filled with material from the A horizon extend to a depth of 36 inches in some pedons. The B horizon is clay or silty clay. The Cg horizon has masses of gypsum crystals in some pedons. In some pedons, the Cg horizon is laminated silty clay, clay, and silty clay loam.

Embden Series

The Embden series consists of deep, moderately well drained, moderately rapidly permeable soils on glacial lake plains and glacial outwash plains. The soils formed in medium textured, moderately coarse textured, and coarse textured glacial outwash sediment and glacial lake sediment. The slope ranges from 1 to 6 percent.

The Embden soils are similar to Heimdal and Svea soils and commonly are adjacent to Maddock and Wyndmere soils. The Heimdal soils have a loam surface layer and subsoil. They have a mollic epipedon that is less than 16 inches thick. They are on glacial till plains. The Svea soils have more clay than the Embden soils and are on glacial till plains. The Maddock soils have a mollic epipedon less than 16 inches thick and have more sand than the Embden soils. Maddock soils are on side slopes and are in higher positions on the landscape than the Embden soils. The Wyndmere soils have a layer of accumulated lime within a depth of 16 inches. They are in lower positions than the Embden soils.

Typical pedon of Embden fine sandy loam, gravelly substratum, 1 to 6 percent slopes, 1,900 feet south and 2,550 feet east of the northwest corner of sec. 33, T. 142 N., R. 51 W.

Ap—0 to 11 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; moderate fine and medium granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots; many very fine pores; neutral; abrupt smooth boundary.

Bw1—11 to 17 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, nonsticky and nonplastic; common very fine roots; many very fine pores; neutral; clear irregular boundary.

Bw2—17 to 24 inches; dark brown (10YR 4/3) fine sandy loam, brown (10YR 5/3) dry; few fine distinct very dark grayish brown (10YR 3/2) mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine pores; neutral; abrupt wavy boundary.

Bk—24 to 31 inches; light brownish gray (2.5Y 6/2) very fine sandy loam, light gray (2.5Y 7/2) dry; moderate coarse prismatic structure parting to moderate subangular blocky; soft, very friable, nonsticky and nonplastic; few very fine roots; many very fine pores; lime disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary.

BCk—31 to 40 inches; grayish brown (2.5Y 5/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; common medium distinct grayish brown (10YR 5/2) mottles; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; many very fine pores; lime disseminated throughout; strong effervescence; mildly alkaline; abrupt smooth boundary.

2C—40 to 44 inches; brown (10YR 4/3) gravelly loamy sand, yellowish brown (10YR 5/4) dry; massive; loose; few very fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

3C—44 to 60 inches; olive brown (2.5Y 4/4) stratified sand, silt, clay, and gravel, light gray (2.5Y 7/2) dry; massive; few very fine roots; slight effervescence; mildly alkaline.

The depth to carbonates is 20 to 60 inches. The mollic epipedon is 16 to 40 inches thick. The Bw horizon is fine sandy loam or loam. The Bk horizon is fine sandy loam, very fine sandy loam, or loamy fine sand. In some pedons the C horizon is fine sandy loam or loam at a depth of 40 inches to a depth of 60 inches.

Emrick Series

The Emrick series consists of deep, well drained, moderately permeable soils on glacial till plains. The soils formed in medium textured glacial till. The slope ranges from 1 to 6 percent.

Emrick soils are similar to Overly and Svea soils and commonly are adjacent to Esmond and Heimdal soils. Overly soils have more clay and less sand than Emrick soils. They are on glacial lake plains. Svea soils have more clay than Emrick soils and are moderately well drained. Esmond soils do not have a Bw horizon. They are on knobs. Heimdal soils have a mollic epipedon that is less than 16 inches thick. They are on side slopes.

Typical pedon of Emrick loam, in an area of Heimdal-Emrick loams, 3 to 6 percent slopes, 2,400 feet north

and 300 feet west of the southeast corner of sec. 33, T. 137 N., R. 55 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak coarse prismatic structure parting to weak medium and fine subangular blocky; slightly hard, very friable, slightly sticky and nonplastic; few very fine roots; few fine and many very fine pores; neutral; abrupt smooth boundary.

A—8 to 16 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak coarse subangular blocky structure parting to weak medium and fine subangular blocky; soft, very friable, slightly sticky and nonplastic; few very fine roots; common very fine pores; neutral; clear wavy boundary.

Bw—16 to 23 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak moderate prismatic structure parting to moderate medium subangular blocky; soft, very friable, slightly sticky and nonplastic; common very fine roots; common very fine pores; neutral; clear smooth boundary.

Bk—23 to 28 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; weak coarse prismatic structure parting to moderate fine subangular blocky; slightly hard, very friable, slightly sticky and nonplastic; common very fine roots; few fine pores; about 5 percent coarse fragments; lime disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary.

C—28 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; weak coarse subangular blocky structure parting to weak fine subangular blocky; soft, very friable, slightly sticky and nonplastic; about 10 percent coarse fragments; lime disseminated throughout; strong effervescence; moderately alkaline.

The solum is 16 to 36 inches thick. The mollic epipedon is 16 to more than 24 inches thick. The lower part of the Bw horizon and of the Bk horizon is mottled in some pedons.

Enloe Series

The Enloe series consists of deep, poorly drained, slowly permeable soils on glacial lake plains. The soils formed in fine textured lacustrine sediment. The slope is 0 to 1 percent.

The Enloe soils are similar to the Tonka soils and commonly are adjacent to Dovray, Fargo, and Hegne soils. Dovray and Fargo soils do not have an E horizon. The Hegne soils have a layer of accumulated lime within a depth of 16 inches and are in slightly convex positions. The Tonka soils have less clay in the Bt horizon than the Enloe soils.

Typical pedon of Enloe silty clay (fig. 20), in an area of Hegne-Enloe silty clays, 600 feet south and 165 feet west of the northeast corner of sec. 21, T. 143 N., R. 49 W.

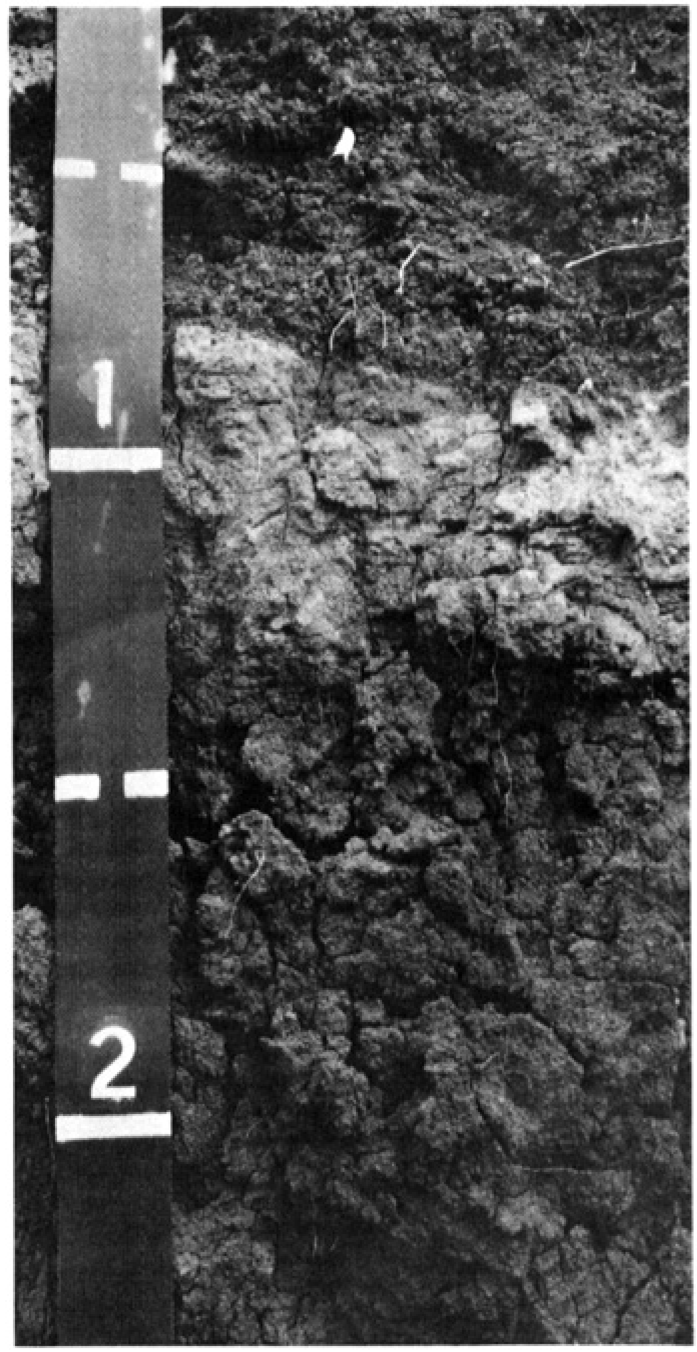

Figure 20.—Profile of Enloe silty clay. The subsoil has prismatic and blocky structure.

Ap—0 to 9 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; weak coarse subangular blocky structure parting to moderate fine granular; hard, firm, very sticky and very plastic; many very fine roots; many very fine pores; neutral; abrupt smooth boundary.

E—9 to 15 inches; dark gray (10YR 4/1) silty clay loam, light gray (10YR 6/1) dry; weak medium prismatic structure parting to moderate medium platy; slightly hard, very friable, slightly sticky and plastic; common very fine roots; common fine and many very fine pores; neutral; abrupt wavy boundary.

Btg1—15 to 30 inches; black (5Y 2/1) clay, very dark gray (5Y 3/1) dry; moderate coarse and medium prismatic structure parting to strong fine angular blocky; very hard, very firm, very sticky and very plastic; common very fine roots; common very fine pores; few thin clay films on faces of peds; neutral; gradual smooth boundary.

Btg2—30 to 42 inches; very dark gray (5Y 3/1) clay, dark gray (5Y 4/1) dry; weak coarse prismatic structure parting to moderate fine blocky; very hard, firm, very sticky and very plastic; few very fine roots; common very fine pores; few thin clay films on faces of peds; neutral; clear smooth boundary.

Cg1—42 to 50 inches; olive gray (5Y 5/2) silty clay, light olive gray (5Y 6/2) dry; weak medium subangular blocky structure; hard, firm, sticky and plastic; common very fine pores; slight effervescence; neutral; gradual smooth boundary.

Cg2—50 to 60 inches; pale olive (5Y 6/3) laminated silt and clay, pale yellow (5Y 7/3) dry; many medium distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; hard, firm, sticky and plastic; strong effervescence; mildly alkaline.

The depth to carbonates ranges from 24 to 60 inches. The thickness of the E horizon ranges widely within a short distance, and the lower boundary is abrupt or clear and is wavy, irregular, or broken. There are slickensides in the lower Bt horizon in some pedons. The Cg horizon is silty clay or clay.

Esmond Series

The Esmond series consists of deep, well drained, moderately permeable soils on glacial till plains. The soils formed in medium textured and moderately coarse textured glacial till. The slope ranges from 6 to 15 percent.

Esmond soils are similar to Buse soils and commonly are adjacent to Heimdal and Emrick soils. Buse soils contain more silt and clay than the Esmond soils. Heimdal soils have a Bw horizon and are below the Esmond soils on the landscape. Emrick soils have a mollic epipedon that is more than 16 inches thick. They are on foot slopes.

Typical pedon of Esmond loam, in an area of Heimdal-Esmond loams, 6 to 9 percent slopes, 2,450 feet south and 200 feet west of the northeast corner of sec. 33, T. 137 N., R. 55 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak coarse subangular blocky structure parting to weak fine subangular blocky; soft, friable, slightly sticky and slightly plastic; many very fine roots; many fine and very fine pores; slight effervescence; mildly alkaline; abrupt smooth boundary.

AB—6 to 12 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure parting to weak fine subangular blocky; soft, friable, slightly sticky and slightly plastic; common fine roots; many very fine and few fine pores; lime disseminated throughout; strong effervescence; moderately alkaline; clear wavy boundary.

Bk—12 to 24 inches; grayish brown (2.5Y 5/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; weak coarse prismatic structure parting to weak medium subangular blocky; soft, friable, slightly sticky and nonplastic; few very fine roots; few very fine pores; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C—24 to 60 inches; olive brown (2.5Y 4/4) fine sandy loam, light yellowish brown (2.5Y 6/4) dry; massive; soft, loose, nonsticky and nonplastic; few very fine roots; few very fine pores; 5 percent coarse fragments; strong effervescence; moderately alkaline.

In some pedons, there are thin pockets or lenses of gravel, sand, or fine sand between depths of 10 and 40 inches. In some pedons there is no AB horizon. The C horizon is loam or fine sandy loam, and in some pedons it is stratified.

Fairdale Series

The Fairdale series consists of deep, moderately well drained, moderately permeable soils on flood plains. The soils formed in medium textured and moderately coarse textured alluvium. The slope ranges from 1 to 3 percent.

Fairdale soils are similar to Cashel soils and are commonly adjacent to Cashel, Fairdale Variant, Fargo, Hegne, and LaDelle soils. Cashel soils contain more clay than Fairdale soils. Fairdale Variant soils are silty clay below a depth of 22 inches. Fargo and Hegne soils are poorly drained and are on glacial lake plains. LaDelle soils contain more silt than Fairdale soils and have a mollic epipedon that is more than 20 inches thick. LaDelle soils are in higher positions on the flood plain than the Fairdale soils; some are on terraces.

Typical pedon of Fairdale silt loam, channeled, 2,590 feet north and 2,300 feet west of the southeast corner of sec. 18, T. 138 N., R. 49 W.

A—0 to 6 inches; very dark brown (10YR 2/2) finely stratified silt loam, alternating dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) dry; weak medium subangular blocky structure parting to moderate very fine subangular blocky; slightly hard, friable, sticky and slightly plastic; many medium, few fine, and common very fine roots; many medium and common fine and very fine pores; slight effervescence; mildly alkaline; clear wavy boundary.

C1—6 to 12 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; many fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure parting to weak very fine subangular blocky; slightly hard, very friable, sticky and slightly plastic; few fine and common very fine roots; common fine and very fine pores; strong effervescence; mildly alkaline; clear wavy boundary.

C2—12 to 16 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; many fine distinct dark brown (10YR 4/3) and yellowish brown (10YR 5/6) mottles; weak fine and very fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; few fine and common very fine pores; strong effervescence; mildly alkaline; clear wavy boundary.

C3—16 to 25 inches; grayish brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; many fine distinct dark brown (10YR 3/3) and dark yellowish brown (10YR 4/4) mottles; weak thin platy structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; common very fine pores; mildly alkaline; strong effervescence; gradual wavy boundary.

C4—25 to 27 inches; dark grayish brown (2.5Y 4/2) loam, grayish brown (2.5Y 5/2) dry; common fine distinct dark yellowish brown (10YR 4/4) mottles; moderate medium platy structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; common very fine pores; strong effervescence; mildly alkaline; gradual wavy boundary.

C5—27 to 60 inches; dark grayish brown (10YR 4/2) fine sandy loam, light brownish gray (10YR 6/2) dry; massive; soft, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine pores; few thin layers of silty clay loam and silt loam; strong effervescence; mildly alkaline.

On the average, the 10- to 40-inch control section is 18 to 30 percent clay and 15 to 50 percent fine sand or coarser. In some pedons, at a depth between 10 and 60 inches, there are one or more dark layers that are 1 to 12 inches thick.

Fairdale Variant

The Fairdale Variant consists of deep, moderately well drained, slowly permeable soils on flood plains. The soils formed in medium textured alluvium overlying fine textured lacustrine sediment. The slope is 0 to 1 percent.

Fairdale Variant soils are similar to Cashel and Fairdale soils and commonly are adjacent to Fairdale, Fargo, Hegne, and LaDelle soils. The Cashel soils have more clay in the upper part than Fairdale Variant soils. The Fairdale soils have more silt and sand than Fairdale Variant soils. Fargo and Hegne soils are poorly drained and are on glacial lake plains. The LaDelle soils have a mollic epipedon that is more than 20 inches thick. The LaDelle soils are on flood plains or terraces and are slightly higher on the landscape than the Fairdale Variant soils.

Typical pedon of Fairdale Variant silt loam, 650 feet south and 200 feet east of the northwest corner of sec. 1, T. 137 N., R. 50 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure parting to weak fine subangular blocky; very hard, friable, sticky and plastic; many fine and very fine roots; few fine and common very fine pores; lime disseminated throughout; strong effervescence; moderately alkaline; abrupt smooth boundary.

C—9 to 22 inches; dark grayish brown (2.5Y 4/2) stratified loam, grayish brown (2.5Y 5/2) dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine roots; few fine and common very fine pores; lime disseminated throughout; violent effervescence; moderately alkaline; abrupt smooth boundary.

2Ab—22 to 29 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure parting to weak fine angular blocky; hard, friable, sticky and plastic; few very fine roots; common very fine pores; neutral; clear wavy boundary.

2Bwb1—29 to 37 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure parting to weak fine angular blocky; very hard, firm, sticky and plastic; few fine and very fine pores; neutral; gradual wavy boundary.

2Bwb2—37 to 47 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; massive; very hard, firm, very sticky and plastic; few fine and common very fine pores; slight effervescence; mildly alkaline; gradual wavy boundary.

2C—47 to 60 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; massive; very hard, firm, very sticky and plastic; few fine and very fine pores;

lime disseminated throughout; violent effervescence; moderately alkaline.

The depth to the 2Ab horizon ranges from 20 to 30 inches. The horizon is silty clay or clay. The C horizon is loam, silt loam, or fine sandy loam. The 2C horizon is silty clay loam, silty clay, or clay.

Fargo Series

The Fargo series consists of deep, poorly drained, slowly permeable soils on glacial lake plains. The soils formed in fine textured lacustrine sediment. The slope ranges from 0 to 3 percent.

Fargo soils commonly are adjacent to Cashel, Dovray, Enloe, Hegne, Ryan, and Wahpeton soils. Cashel soils are stratified below the surface layer and are on flood plains. Dovray and Wahpeton soils have a mollic epipedon that is more than 24 inches thick. Dovray soils are in depressions. Enloe soils have an albic horizon. They also are in depressions. Wahpeton soils are on levees on flood plains. Hegne soils have a layer of accumulated lime within a depth of 16 inches. They are in higher positions than the Fargo soils. Ryan soils contain salts and have a natric horizon.

Typical pedon of Fargo silty clay (fig. 21), 1,500 feet south and 2,600 feet east of northwest corner of sec. 8, T. 139 N., R. 51 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure parting to weak fine subangular blocky; very hard, friable, sticky and plastic; few fine and many very fine roots; common very fine pores; neutral; abrupt smooth boundary.

A—7 to 10 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak medium and fine subangular blocky structure; very hard, friable, slightly sticky and plastic; few fine and many very fine roots; common very fine pores; neutral; gradual smooth boundary.

Bw1—10 to 16 inches; very dark gray (5Y 3/1) silty clay, dark gray (5Y 4/1) dry; moderate medium prismatic structure parting to weak fine angular blocky; very hard, firm, sticky and plastic; few fine and many very fine roots; few fine pores; faces of peds have shiny waxy sheen when moist; tongues of A horizon material throughout; slight effervescence in the lower part; neutral; gradual wavy boundary.

Bw2—16 to 22 inches; dark gray (5Y 4/1) silty clay, gray (5Y 5/1) dry; weak medium prismatic structure parting to weak fine angular blocky; very hard, friable, sticky and plastic; common very fine roots; few fine pores; faces of peds have shiny waxy sheen when moist; tongues of A horizon material throughout; strong effervescence; mildly alkaline; gradual wavy boundary.

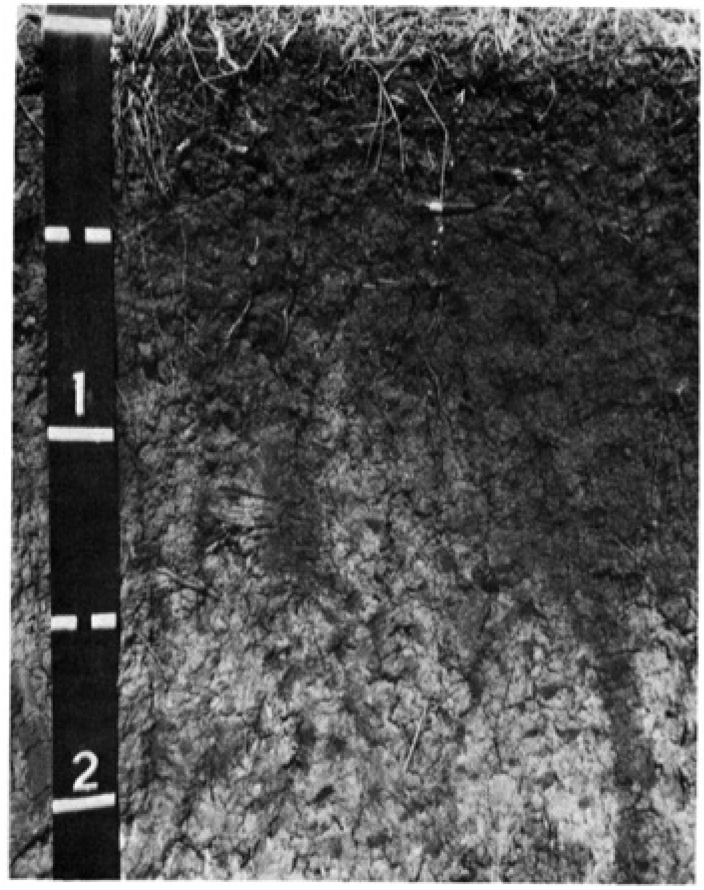

Figure 21.—Profile of Fargo silty clay. Tongues of surface layer material extend to a depth of 24 inches or more.

BCkg—22 to 30 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; weak fine prismatic structure parting to weak medium subangular blocky; very hard, firm, sticky and plastic; few very fine roots; tongues of A horizon material; lime disseminated throughout; strong effervescence; mildly alkaline; gradual wavy boundary.

Cg1—30 to 45 inches; olive gray (5Y 4/2) silty clay, olive gray (5Y 5/2) dry; weak fine prismatic structure parting to weak medium subangular blocky; very hard, firm, sticky and plastic; few very fine roots; strong effervescence; mildly alkaline; gradual wavy boundary.

Cg2—45 to 60 inches; olive gray (5Y 4/2) silty clay, olive gray (5Y 5/2) dry; common medium prominent dark brown (7.5YR 4/4) mottles; massive; very hard, firm, sticky and plastic; few medium masses of segregated lime; strong effervescence; moderately alkaline.

The solum ranges from 16 to 36 inches in thickness. The mollic epipedon ranges from 8 to 24 inches in thickness. In some pedons this soil is saline. The A horizon is silty clay or silty clay loam. Tongues of A horizon material range from 1/2 inch to 5 inches in width. The lower part of the B horizon is mottled in some pedons. The Cg2 horizon has common to many, distinct or prominent, low or high chroma mottles. In some pedons, laminated silty clay, clay, and silty clay loam are in the lower part of the Cg horizon.

Galchutt Series

The Galchutt series consists of deep, somewhat poorly drained, slowly permeable soils on glacial lake plains. The soils formed in medium textured material overlying fine textured lacustrine sediment. The slope is 0 to 1 percent.

The Galchutt soils commonly are adjacent to Fargo, Glyndon, and Tiffany soils. Fargo soils have more clay in the upper part than Galchutt soils and are poorly drained. The Fargo soils are in swales and slight depressions. The Glyndon soils have more silt and less clay in the lower part than Galchutt soils and have a layer of accumulated lime within a depth of 16 inches. The Tiffany soils have more sand and less clay than Galchutt soils. They are in depressions.

Typical pedon of Galchutt silty clay loam, in an area of Galchutt-Fargo silty clay loams, 140 feet east and 420 feet south of the northwest corner of sec. 24, T. 141 N., R. 52 W.

Ap—0 to 10 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak coarse subangular blocky structure parting to moderate fine subangular blocky; hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; many very fine and fine pores; neutral; abrupt smooth boundary.

A—10 to 17 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak prismatic structure parting to weak, moderate and strong subangular blocky; hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine pores; neutral; clear smooth boundary.

E—17 to 25 inches; dark grayish brown (10YR 4/2) very fine sandy loam, grayish brown (10YR 5/2) dry; few fine faint dark yellowish brown (10YR 3/4) mottles; weak coarse prismatic structure parting to weak thin platy; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common fine and very fine pores; neutral; abrupt wavy boundary.

2Bt—25 to 31 inches; olive gray (5Y 4/2) silty clay, olive gray (5Y 5/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; weak very coarse prismatic structure parting to weak and moderate fine angular blocky; hard, friable, sticky and plastic; few very fine roots; common thin clay films on faces of peds; few fine pores; neutral; clear wavy boundary.

2C1—31 to 47 inches; olive gray (5Y 4/2) silty clay, light olive gray (5Y 6/2) dry; few fine faint yellowish brown (10YR 5/6) mottles; massive; hard, very friable, sticky and plastic; few very fine pores; slight effervescence; mildly alkaline; gradual smooth boundary.

2C2—47 to 60 inches; olive gray (5Y 4/2) silty clay, light olive gray (5Y 6/2) dry; common medium distinct brown (7.5YR 4/4) mottles; massive; hard, very friable, sticky and plastic; common slickensides; slight effervescence; mildly alkaline.

The solum ranges from 23 to 58 inches in thickness. The mollic epipedon ranges from 12 to 24 inches in thickness. The Ap horizon is silty clay loam, silt loam, or fine sandy loam. The E horizon is very fine sandy loam, loam, or silt loam. The 2Bt horizon is silty clay or clay. The 2C horizon is silty clay or clay. It is stratified and multicolored in some pedons. The 2C horizon has common to many, faint to prominent mottles.

Gardena Series

The Gardena series consists of deep, moderately well drained, moderately permeable soils on glacial lake plains. The soils formed in medium textured lacustrine sediment. The slope ranges from 0 to 3 percent.

Gardena soils are similar to Overly soils and commonly are adjacent to Glyndon, Overly, Tiffany, and Wyndmere soils. Overly soils have more clay than Gardena soils. Glyndon and Wyndmere soils have a layer of accumulated lime within a depth of 16 inches. In addition, Wyndmere soils have more sand than the Gardena soils. Tiffany soils have more sand and less silt than Gardena soils and are poorly drained. Glyndon, Tiffany, and Wyndmere soils are lower on the landscape than the Gardena soils.

Typical pedon of Gardena silt loam, in an area of Gardena-Glyndon silt loams, 2,550 feet south and 2,450 feet west of the northeast corner of sec. 27, T. 143 N., R. 55 W.

Ap—0 to 7 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to weak fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; few fine and common very fine pores; mildly alkaline; abrupt smooth boundary.

A—7 to 11 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to weak fine subangular blocky; soft, friable, slightly sticky and slightly plastic; common fine and very fine roots; common

fine and very fine pores; mildly alkaline; abrupt smooth boundary.

Bw1—11 to 17 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to weak medium subangular blocky; soft, friable, slightly sticky and slightly plastic; few fine and common very fine roots; common fine and very fine pores; mildly alkaline; gradual wavy boundary.

Bw2—17 to 20 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common fine and very fine pores; strong effervescence; moderately alkaline; gradual wavy boundary.

Bk—20 to 25 inches; grayish brown (2.5Y 5/2) silt loam, light gray (2.5Y 7/2) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common fine and very fine pores; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—25 to 31 inches; grayish brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common fine and very fine pores; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—31 to 60 inches; light yellowish brown (2.5Y 6/4) silt loam, pale yellow (2.5Y 7/4) dry; common medium distinct yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few fine and common very fine pores; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to carbonates range from 14 to 40 inches. The thickness of the mollic epipedon ranges from 16 to 40 inches. The B horizon is silt loam, loam, or very fine sandy loam. In some pedons the C horizon is coarser or finer textured at a depth of 40 inches or more.

Glyndon Series

The Glyndon series consists of deep, somewhat poorly drained, moderately rapidly permeable soils on glacial lake plains. The soils formed in medium textured lacustrine sediment. The slope ranges from 0 to 3 percent.

Glyndon soils are similar to Bearden and Wyndmere soils and commonly are adjacent to Bearden, Gardena, Tiffany, and Wyndmere soils. Bearden soils have more clay than Glyndon soils. Gardena soils have a mollic epipedon that is more than 16 inches thick. Gardena soils are above Glyndon soils on the landscape. Tiffany soils do not have a layer of accumulated lime within a depth of 16 inches. Tiffany soils are lower on the landscape than the Glyndon soils. Wyndmere soils have more sand and less silt than the Glyndon soils.

Typical pedon of Glyndon silt loam, in an area of Glyndon-Tiffany silt loams, 2,100 feet south and 2,100 feet west of the northeast corner of sec. 2, T. 140 N., R. 52 W.

Ap—0 to 6 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to weak very fine subangular blocky; hard, very friable, slightly sticky and slightly plastic; common very fine roots; few very fine pores; slight effervescence; mildly alkaline; abrupt smooth boundary.

A—6 to 12 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; few very fine pores; slight effervescence; mildly alkaline; abrupt smooth boundary.

Bk1—12 to 23 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; few fine distinct strong brown (7.5YR 4/6) mottles; weak coarse subangular blocky structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; few very fine pores; lime disseminated throughout; violent effervescence; moderately alkaline; abrupt smooth boundary.

Bk2—23 to 28 inches; olive brown (2.5Y 4/4) silt loam, light olive brown (2.5Y 5/4) dry; few fine distinct strong brown (7.5YR 4/6) mottles; weak medium subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; few very fine roots; lime disseminated throughout; strong effervescence; moderately alkaline; gradual smooth boundary.

C1—28 to 34 inches; light olive brown (2.5Y 5/4) very fine sandy loam, light yellowish brown (2.5Y 6/4) dry; common fine and medium distinct dark brown (7.5YR 3/4) and strong brown (7.5YR 4/6) mottles; massive; hard, very friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—34 to 60 inches; light olive brown (2.5Y 5/4) stratified silt loam, light yellowish brown (2.5Y 6/4) dry; many medium and coarse distinct and prominent strong brown (7.5YR 4/6), dark grayish brown (2.5Y 4/2), and light gray (5Y 7/2) mottles; massive; very hard, friable, slightly sticky and slightly plastic; slight effervescence; mildly alkaline.

The mollic epipedon ranges from 7 to 16 inches in thickness. Some pedons are saline. The Bk horizon is very fine sandy loam, sandy clay loam, or silt loam. The

C2 horizon is very fine sand, loamy very fine sand, or silt loam.

Hamerly Series

The Hamerly series consists of deep, somewhat poorly drained, moderately slowly permeable soils on glacial till plains. The soils formed in medium textured glacial till. The slope ranges from 0 to 6 percent.

Hamerly soils are similar to Bearden soils and commonly are adjacent to Svea, Tonka, Vallers, and Wyard soils. Bearden soils contain more silt and less sand than the Hamerly soils. Tonka, Svea, and Wyard soils do not have a layer of accumulated lime within a depth of 16 inches. Svea soils are on foot slopes and Tonka and Wyard soils are in depressions. Vallers soils are poorly drained and are on the rim of depressions.

Typical pedon of Hamerly loam, in an area of Wyard-Hamerly loams, 1 to 3 percent slopes, 70 feet south and 30 feet east of the northwest corner sec. 6, T. 143 N., R. 55 W.

Ap—0 to 5 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure parting to moderate medium granular; hard, friable, slightly sticky and nonplastic; many very fine roots; many very fine pores; slight effervescence; mildly alkaline; abrupt smooth boundary.

A—5 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate coarse prismatic structure parting to moderate coarse subangular blocky; hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine pores; slight effervescence; mildly alkaline; gradual wavy boundary.

Bk—10 to 24 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; weak coarse subangular blocky structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; many very fine pores; lime disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary.

C1—24 to 37 inches; olive (5Y 5/3) loam, pale yellow (5Y 7/3) dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; common very fine pores; 5 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—37 to 48 inches; olive (5Y 5/3) loam, pale yellow (5Y 7/3) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine pores; 5 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

C3—48 to 60 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; few fine prominent red (2.5YR 4/6) mottles; massive; hard, friable, slightly sticky and slightly plastic; common very fine pores; 10 percent coarse fragments; strong effervescence; moderately alkaline.

In some pedons the A horizon does not have free carbonates. In some pedons there is an ABk horizon. In some pedons the C horizon has visible gypsum crystals. Some pedons are saline.

Hegne Series

The Hegne series consists of deep, poorly drained, very slowly permeable soils on glacial lake plains. The soils formed in fine textured lacustrine sediments. The slope is 0 to 1 percent.

Hegne soils are similar to Colvin soils and commonly are adjacent to Dovray, Enloe, and Fargo soils. Colvin soils contain less clay than Hegne soils. Dovray soils have a mollic epipedon more than 24 inches thick and are in depressions. Enloe soils have an albic horizon. They also are in depressions. Fargo soils do not have a layer of accumulated lime within a depth of 16 inches. They are lower on the landscape than the Hegne soils.

Typical pedon of Hegne silty clay, in an area of Fargo-Hegne silty clays, 2,150 feet south and 1,950 feet east of the northwest corner of sec. 6, T. 139 N., R. 50 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; hard, friable, very sticky and plastic; few fine and common very fine roots; few fine and common very fine pores; slight effervescence; mildly alkaline; clear smooth boundary.

Bkg1—7 to 19 inches; dark gray (5Y 4/1) silty clay, gray (5Y 5/1) dry; moderate medium subangular blocky structure parting to moderate very fine angular blocky; hard, firm, very sticky and plastic; few very fine roots; few very fine pores; lime disseminated throughout; violent effervescence; moderately alkaline; clear smooth boundary.

Bkg2—19 to 31 inches; dark gray (5Y 4/1) silty clay, gray (5Y 5/1) dry; weak coarse subangular blocky structure parting to moderate very fine angular blocky; very hard, firm, very sticky and plastic; few very fine roots; few very fine pores; lime disseminated throughout; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg1—31 to 46 inches; olive gray (5Y 4/2) silty clay, olive gray (5Y 5/2) dry; moderate fine angular blocky structure; very hard, firm, very sticky and plastic; few very fine pores; slight effervescence; mildly alkaline; clear smooth boundary.

Cg2—46 to 60 inches; olive gray (5Y 4/2) silty clay, olive gray (5Y 5/2) dry; common medium distinct yellowish brown (10YR 5/6) and few fine distinct dark brown (7.5YR 4/2) mottles; weak fine angular

blocky structure; very hard, firm, very sticky and very plastic; slight effervescence; mildly alkaline.

The mollic epipedon ranges from 7 to 16 inches in thickness. The A horizon is silty clay or silty clay loam. In some pedons, tongues filled with A horizon material extend to a depth of 36 inches. The Cg horizon is silty clay, clay, or silty clay loam.

Heimdal Series

The Heimdal series consists of deep, well drained, moderately permeable soils on glacial till plains. The soils formed in medium textured and coarse textured glacial till. The slope ranges from 1 to 15 percent.

Heimdal soils are similar to Barnes soils and commonly are adjacent to Emrick and Esmond soils. Barnes soils have more clay than the Heimdal soils. Emrick soils have a mollic epipedon that is more than 16 inches thick. They are on foot slopes. Esmond soils do not have a Bw horizon. They are on knobs.

Typical pedon of Heimdal loam, in an area of Heimdal-Emrick loams, 3 to 6 percent slopes, 2,450 feet north and 1,000 feet west of the southeast corner of sec. 33, T. 137 N., R. 55 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to weak medium subangular blocky; soft, very friable, slightly sticky and nonplastic; few fine and many very fine roots; few fine and common very fine pores; neutral; abrupt smooth boundary.

Bw1—6 to 10 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to weak medium subangular blocky; soft, very friable, slightly sticky and nonplastic; common very fine roots; few fine and common very fine pores; neutral; abrupt smooth boundary.

Bw2—10 to 15 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; moderate medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky and nonplastic; few very fine roots; common very fine pores; neutral; clear wavy boundary.

Bk—15 to 32 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; weak medium prismatic structure parting to weak fine subangular blocky; soft, very friable, slightly sticky and nonplastic; few very fine roots; common very fine pores; few small masses and common fine threads of lime; strong effervescence; moderately alkaline; clear smooth boundary.

C1—32 to 48 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; few fine distinct light gray (10YR 6/1) and yellowish brown (10YR 5/8) weathered fragments; weak coarse subangular blocky structure; soft, very friable, slightly sticky and nonplastic; common very fine pores; lime disseminated throughout; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—48 to 60 inches; light olive brown (2.5Y 5/4) stratified fine sand, pale yellow (2.5Y 7/4) dry; few fine distinct light gray (10YR 6/1) and yellowish brown (10YR 5/8) mottles; massive; soft, very friable, slightly sticky and nonplastic; common very fine pores; lime disseminated throughout; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick. The solum is 12 to 38 inches thick. Some pedons have a BC horizon. The C horizon is fine sand, loam, or silt loam.

LaDelle Series

The LaDelle series consists of deep, moderately well drained, moderately permeable soils on flood plains. The soils formed in medium textured and moderately fine textured alluvium. The slope is 0 to 1 percent.

LaDelle soils are similar to Overly soils and commonly are adjacent to Fairdale, Fairdale Variant, Lamoure, and Overly soils. In the Overly soils, the content of organic matter decreases regularly with depth. The Overly soils are on glacial lake plains. The Fairdale soils have more sand than the LaDelle soils, and they are in lower positions on the flood plain. The Fairdale Variant soils contain more sand in the upper 22 inches than LaDelle soils and are silty clay below a depth of 22 inches. The Fairdale Variant soils are on splays and natural levees on the flood plain. The Lamoure soils are poorly drained and are in lower positions on the flood plain than the LaDelle soils.

Typical pedon of LaDelle silty clay loam, 1,130 feet north and 1,500 feet east of the southwest corner of sec. 13, T. 137 N., R. 50 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and plastic; few medium and many fine roots; common very fine pores; neutral; abrupt smooth boundary.

A—8 to 14 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and plastic; common fine and very fine roots; few fine and common very fine pores; neutral; abrupt wavy boundary.

Bw—14 to 33 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable, sticky and plastic; common fine and very fine roots; many very fine pores; few lime concretions; strong effervescence; mildly alkaline; clear smooth boundary.

C1—33 to 41 inches; very dark grayish brown (2.5Y 3/2) silty clay loam, grayish brown (2.5Y 5/2) dry; massive; hard, friable, sticky and plastic; few fine and very fine roots; many very fine pores; lime disseminated throughout; violent effervescence; moderately alkaline; abrupt wavy boundary.

Ab—41 to 45 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; massive; slightly hard, friable, sticky and plastic; common very fine roots; many very fine pores; common fine lime concretions; slight effervescence; mildly alkaline; abrupt wavy boundary.

C2—45 to 60 inches; grayish brown (2.5Y 5/2) stratified loam and clay loam, light brownish gray (2.5Y 6/2) dry; massive; hard, friable, sticky and plastic; few fine roots; many very fine pores; lime disseminated throughout; violent effervescence; moderately alkaline.

The mollic epipedon ranges from 20 to 50 inches in thickness. The C2 horizon is stratified with thin layers of sand, loam, silt, clay loam, or clay.

Lamoure Series

The Lamoure series consists of deep, poorly drained, moderately permeable soils on flood plains. The soils formed in medium textured alluvium. The slope is 0 to 1 percent.

Lamoure soils are similar to Rauville soils and commonly are adjacent to Colvin, LaDelle, and Rauville soils. Colvin soils have a layer of accumulated lime within a depth of 16 inches. LaDelle soils are moderately well drained and are in higher positions on the flood plains than the Lamoure soils. Rauville soils are very poorly drained and are in lower positions on the flood plain than the Lamoure soils.

Typical pedon of Lamoure silty clay loam, 375 feet north and 2,100 feet east of the southwest corner of sec. 5, T. 139 N., R. 55 W.

A1—0 to 7 inches; black (10YR 2/1) silty clay loam; very dark gray (10YR 3/1) dry; moderate medium and fine subangular blocky structure parting to moderate medium granular; slightly hard, friable, slightly sticky and slightly plastic; many coarse and medium roots; many medium and fine pores; mildly alkaline; gradual wavy boundary.

A2—7 to 14 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine and fine roots; few medium and common fine and very fine pores; slight effervescence; mildly alkaline; gradual wavy boundary.

A3—14 to 25 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; many fine faint very dark grayish brown (10YR 3/2) mottles; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; few fine and common very fine roots; many fine and very fine pores; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Cg1—25 to 43 inches; grayish brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; massive; slightly hard, friable, sticky and plastic; common fine and very fine pores; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Cg2—43 to 60 inches; grayish brown (2.5Y 5/2) stratified loam and silty clay loam, light brownish gray (2.5Y 6/2) dry; common fine distinct yellowish brown (10YR 5/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine and common very fine pores; lime disseminated throughout; violent effervescence; moderately alkaline.

The solum and the mollic epipedon range from 24 to 42 inches in thickness. The Cg2 horizon is stratified loam, silty clay loam, silt loam, or sandy loam. The Cg horizon has few to many, faint or distinct mottles.

Lindaas Series

The Lindaas series consists of deep, poorly drained, slowly permeable soils on glacial lake plains. The soils formed in medium textured and moderately fine textured lacustrine sediment. The slope is 0 to 1 percent.

Lindaas soils are similar to Parnell soils and commonly adjacent to Bearden, Fargo, and Overly soils. Parnell soils have carbonates below a depth of 35 inches. None of the adjacent soils has an argillic horizon. Bearden soils have a layer of accumulated lime within a depth of 16 inches. Overly soils are moderately well drained. All of the adjacent soils are in positions on the landscape that are higher than those of the Lindaas soil.

Typical pedon of Lindaas silty clay loam, in an area of Bearden-Lindaas silty clay loams, 740 feet south and 960 feet west of the northeast corner of sec. 26, T. 141 N., R. 51 W.

Ap—0 to 6 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; common fine pores; neutral; abrupt smooth boundary.

A—6 to 11 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine pores; neutral; abrupt smooth boundary.

Bt1—11 to 16 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; many very fine roots; few very fine pores; organic stains and clay films on faces of prisms and blocks; neutral; clear wavy boundary.

Bt2—16 to 24 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; many very fine roots; few fine pores; organic stains and clay films on faces of prisms and blocks; neutral; gradual wavy boundary.

Bk1—24 to 32 inches; grayish brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; few fine distinct light olive brown (2.5Y 5/4) mottles; weak medium prismatic structure parting to weak medium subangular blocky; soft, very friable, sticky and plastic; common very fine roots; few very fine and common fine pores; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk2—32 to 36 inches; grayish brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; common fine distinct light olive brown (2.5Y 5/4) mottles; weak coarse prismatic structure; slightly hard, friable, sticky and plastic; few very fine roots; common fine and few very fine pores; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Cg1—36 to 43 inches; light brownish gray (2.5Y 6/2) silty clay loam, light gray (2.5Y 7/2) dry; many fine distinct dark yellowish brown (10YR 3/6) mottles; weak thick platy structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg2—43 to 60 inches; light brownish gray (2.5Y 6/2) and light yellowish brown (10YR 6/4) alternating layers of very fine sandy loam, silt loam and silty clay loam, light gray (2.5Y 7/2) and very pale brown (10YR 7/4) dry; few fine prominent black (N 2/0) mottles; weak thick platy structure; hard, friable, slightly sticky and slightly plastic; moderately alkaline; strong effervescence.

The solum ranges from 24 to 48 inches in thickness. The depth to carbonates ranges from 24 to 35 inches. The Bt horizon is silty clay or clay.

Maddock Series

The Maddock series consists of deep, well drained, rapidly permeable soils on glacial lake and delta plains. The soils formed in coarse textured, water-deposited sediment. The slope ranges from 1 to 6 percent.

Maddock soils commonly are adjacent to Embden soils on the landscape. The Embden soils have a mollic epipedon that is more than 16 inches thick and have less sand than the Maddock soils. They are in lower positions on the landscape than the Maddock soils.

Typical pedon of Maddock fine sandy loam, 1 to 6 percent slopes, 90 feet north and 2,000 feet west of the southeast corner of sec. 16, T. 143 N., R. 54 W.

Ap—0 to 7 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; moderate coarse subangular blocky structure parting to weak fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; common very fine pores; neutral; abrupt smooth boundary.

Bw—7 to 13 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; moderate coarse subangular blocky structure parting to weak fine subangular blocky; soft, very friable, nonsticky and nonplastic; common fine roots; common very fine pores; neutral; clear wavy boundary.

C1—13 to 28 inches; olive brown (2.5Y 4/4) loamy sand, light olive brown (2.5Y 5/4) dry; moderate medium subangular blocky structure; soft, loose, nonsticky and nonplastic; few very fine roots; common very fine pores; mildly alkaline; gradual wavy boundary.

C2—28 to 60 inches; grayish brown (2.5Y 5/2) loamy fine sand, light brownish gray (2.5Y 6/2) dry; massive; soft, loose, nonsticky and nonplastic; common very fine pores; lime disseminated throughout; strong effervescence; mildly alkaline.

The mollic epipedon ranges from 10 to 16 inches in thickness. The depth to carbonates ranges from 20 to 35 inches. The Bw horizon is loamy sand, loamy fine sand, or fine sand. In some places, the C horizon is 1 to 5 percent coarse fragments.

Nahon Series

The Nahon series consists of deep, moderately well drained, very slowly permeable, alkali (sodic) soils on glacial lake plains. The soils formed in moderately fine textured and medium textured lacustrine sediment. The slope ranges from 0 to 2 percent.

The Nahon soils commonly are adjacent to Bearden, Hamerly, and Barnes soils. Bearden and Hamerly soils have a layer of accumulated lime within 16 inches of the surface. They are above the Nahon soils on the landscape. Unlike the Nahon soils, the Barnes soils do not have a natric horizon. The Barnes soils are on side slopes.

Typical pedon of Nahon silt loam, 0 to 2 percent slopes, 225 feet south and 850 feet east of the northwest corner of sec. 5, T. 139 N., R. 55 W.

Ap—0 to 6 inches; black (10YR 2/1) and very dark gray (10YR 3/1) silt loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak medium and fine granular; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; common very fine pores; neutral; abrupt smooth boundary.

E—6 to 8 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak coarse subangular blocky structure parting to weak medium and thin platy; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; common fine and very fine pores; neutral; abrupt smooth boundary.

Bt1—8 to 13 inches; black (10YR 2/1) and very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium columnar structure parting to strong fine angular blocky; hard, firm, sticky and plastic; common fine and very fine roots; common fine and many very fine pores; common, thin clay films on faces of peds; moderately alkaline; clear wavy boundary.

Bt2—13 to 18 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak coarse prismatic structure parting to moderate medium and fine angular blocky; hard, firm, sticky and plastic; few fine and common very fine roots; many very fine pores; common, thin clay films on faces of peds; moderately alkaline; gradual wavy boundary.

BCkz—18 to 34 inches; light olive gray (5Y 6/2) silt loam, white (5Y 8/2) dry; weak coarse prismatic structure parting to weak fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common fine and many very fine pores; few fine nests of salt and lime; violent effervescence; strongly alkaline; gradual wavy boundary.

Cz1—34 to 44 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; few fine distinct dark brown (7.5YR 4/4) mottles; massive; hard, friable, slightly sticky and slightly plastic; common fine and very fine pores; few fine nests of salts; violent effervescence; strongly alkaline; gradual wavy boundary.

Cz2—44 to 60 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; common fine distinct gray (N 6/0) and few fine distinct yellowish brown (10YR 5/4) mottles; massive; hard, friable, slightly sticky and slightly plastic; few fine and common very fine pores; few fine nests of salts; strong effervescence; moderately alkaline.

The solum is 14 to 44 inches thick. The Bt horizon is silty clay or silty clay loam. The Cz horizon is silt loam, loam, clay loam, or silty clay loam.

Nutley Series

The Nutley series consists of deep, well drained, slowly permeable soils on glacial lake plains. The soils formed in fine textured and moderately fine textured lacustrine sediment. The slope ranges from 3 to 9 percent.

The Nutley soils commonly are adjacent to Cashel, Fargo, Hegne, and Wahpeton soils on the landscape. Cashel soils are somewhat poorly drained and are on flood plains. Fargo soils are poorly drained and are in swales and slight depressions. Hegne soils have a layer of accumulated lime within a depth of 16 inches. They are on swells of the glacial lake plain. Wahpeton soils have a mollic epipedon that is more than 24 inches thick. They are on flood plains.

Typical pedon of Nutley silty clay, in an area of Nutley-Fargo silty clays, 1 to 9 percent slopes, 735 feet south and 140 feet east of the northwest corner of sec. 35, T. 141 N., R. 49 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak fine and medium granular structure; hard, friable, sticky and plastic; many medium and fine roots; many fine and very fine pores; mildly alkaline; clear wavy boundary.

Bw1—8 to 15 inches; dark grayish brown (10YR 4/2) and very dark grayish brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) and dark gray (10YR 4/1) dry; weak fine prismatic structure parting to moderate medium and fine subangular blocky; hard, friable, sticky and plastic; many fine roots; many fine and very fine pores; cracks filled with A horizon material throughout; slight effervescence; mildly alkaline; gradual wavy boundary.

Bw2—15 to 21 inches; dark grayish brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; weak medium prismatic structure parting to moderate medium and fine subangular blocky; hard, friable, sticky and plastic; common very fine roots; common fine and very fine pores; cracks filled with A horizon material throughout; lime disseminated throughout; strong effervescence; moderately alkaline; clear wavy boundary.

Bk1—21 to 32 inches; grayish brown (2.5Y 5/2) silty clay, light brownish gray (2.5Y 6/2) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; common very fine roots; few fine and common very fine pores; cracks filled with A horizon material throughout; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk2—32 to 38 inches; grayish brown (2.5Y 5/2) silty clay, light brownish gray (2.5Y 6/2) dry; common fine and few medium prominent reddish yellow

(7.5YR 6/8) mottles; moderate medium subangular blocky structure parting to moderate fine and very fine subangular blocky; hard, very firm, sticky and plastic; few very fine roots; few fine and common very fine pores; lime disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary.

C—38 to 60 inches; alternating layers of grayish brown (2.5Y 5/2) silty clay loam, silty clay, and clay, light brownish gray (2.5Y 6/2) dry; common fine distinct light yellowish brown (10YR 6/4) and few medium prominent reddish yellow (7.5YR 6/6) mottles; massive; hard, very firm, sticky and plastic; few fine and common very fine pores; lime disseminated throughout; violent effervescence; moderately alkaline.

The solum is 14 to 40 inches thick. The mollic epipedon is 7 to 16 inches thick. The Bw horizon is silty clay or clay. In some pedons, there are gypsum crystals at a depth of 30 inches or more.

Overly Series

The Overly series consists of deep, moderately well drained, moderately slowly permeable soils on glacial lake plains. The soils formed in moderately fine textured lacustrine sediment. The slope ranges from 0 to 6 percent.

Overly soils are similar to Gardena and LaDelle soils and commonly are adjacent to Bearden, Fargo, Lindaas, and Perella soils. Gardena soils have less clay than Overly soils. LaDelle soils have an irregular decrease in organic matter and are on terraces and flood plains. Bearden soils have a layer of accumulated lime within 16 inches of the surface. Fargo, Lindaas, and Perella soils are poorly drained. Lindaas soils have an argillic horizon. Bearden, Fargo, Lindaas, and Perella soils are in lower positions on the landscape than the Overly soils

Typical pedon of Overly silty clay loam, 0 to 3 percent slopes, 1,350 feet north and 2,040 feet west of the southeast corner of sec. 4, T. 139 N., R. 51 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak coarse subangular blocky structure parting to weak fine granular; hard, friable, sticky and plastic; few fine and many very fine roots; common very fine pores; neutral; abrupt smooth boundary.

Bw1—8 to 14 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, sticky and plastic; few fine and many very fine roots; common very fine pores; mildly alkaline; abrupt smooth boundary.

Bw2—14 to 18 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, sticky and plastic; common very fine roots; common very fine pores; lime disseminated throughout; slight effervescence; mildly alkaline; clear wavy boundary.

Bk—18 to 31 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; moderate medium prismatic structure parting to moderate medium granular; slightly hard, friable, sticky and plastic; common very fine roots; few very fine pores; lime disseminated throughout; violent effervescence; moderately alkaline; clear smooth boundary.

C1—31 to 40 inches; light olive brown (2.5Y 5/4) silty clay loam, pale yellow (2.5Y 7/4) dry; common fine prominent dark yellowish brown (10YR 4/6) mottles; weak coarse prismatic structure; slightly hard, friable, sticky and plastic; few very fine roots; lime disseminated throughout; strong effervescence; moderately alkaline; clear wavy boundary.

C2—40 to 60 inches; light olive brown (2.5Y 5/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; common medium prominent dark yellowish brown (10YR 4/6) mottles; weak medium prismatic structure; slightly hard, very friable, slightly sticky and plastic; strong effervescence; moderately alkaline.

The solum is 16 to 38 inches thick. The mollic epipedon is 16 to 30 inches thick. The Ap horizon is silty clay loam or silt loam. The C2 horizon is typically silty clay loam, but the range includes clay loam, silt loam, and silty clay.

Parnell Series

The Parnell series consists of deep, very poorly drained, slowly permeable soils on glacial till plains. The soils formed in medium textured and moderately fine textured alluvium from glacial drift. The slope is 0 to 1 percent.

Parnell soils are similar to Lindaas soils and commonly are adjacent to Hamerly, Tonka, and Vallers soils. Lindaas soils have carbonates within a depth of 35 inches. Hamerly and Vallers soils have a layer of accumulated lime within a depth of 16 inches and have less clay than Parnell soils. Tonka soils have an albic horizon. They are in shallow depressions. Hamerly, Tonka, and Vallers soils are higher on the landscape than the Parnell soils.

Typical pedon of Parnell silty clay loam, 400 feet south and 1,075 feet west of the northeast corner of sec. 5, T. 138 N., R. 54 W.

A1—0 to 10 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium

subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common fine pores; neutral; clear smooth boundary.

A2—10 to 18 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak thin platy structure; hard, friable, slightly sticky and slightly plastic; common fine roots; common fine and very fine pores; neutral; clear smooth boundary.

Btg1—18 to 29 inches; very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; few fine and very fine roots; few fine and very fine pores; thin patchy clay films on faces of blocks; neutral; gradual smooth boundary.

Btg2—29 to 40 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; few fine distinct yellowish brown (10YR 5/4) mottles; weak medium prismatic structure parting to strong medium subangular blocky; hard, firm, sticky and plastic; many thin clay films on faces of blocks; neutral; gradual wavy boundary.

Cg1—40 to 48 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; common fine distinct light olive brown (2.5Y 5/6) mottles; massive; hard, friable, slightly sticky and slightly plastic; lime disseminated throughout; slight effervescence; mildly alkaline; gradual wavy boundary.

Cg2—48 to 60 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; common medium prominent yellowish brown (10YR 5/6) and few medium distinct olive gray (5Y 5/2) mottles; massive; hard, friable, slightly sticky and slightly plastic; lime disseminated throughout; slight effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 24 to 60 inches. The thickness of the solum ranges from 35 to 60 inches. Some pedons have an O horizon. The Bt horizon is silty clay loam, silty clay, or clay loam. The Cg horizon is loam, clay loam, or silty clay loam.

Perella Series

The Perella series consists of deep, somewhat poorly drained and poorly drained, moderately slowly permeable soils on glacial lake plains. The soils formed in medium and moderately fine textured lacustrine sediments. The slope is 0 to 1 percent.

Perella soils are similar to Colvin soils and commonly are adjacent to Bearden, Colvin, Fargo, and Lindaas soils. Bearden and Colvin soils have a layer of accumulated lime within a depth of 16 inches. Fargo soils contain more clay than Perella soils. Bearden and Fargo soils are above the Perella soils on the landscape. Lindaas soils have an argillic horizon and are below the Perella soils on the landscape.

Typical pedon of Perella silty clay loam, 2,450 feet north and 1,500 feet east of the southwest corner of sec. 33, T. 142 N., R. 50 W.

Ap—0 to 7 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure; hard, friable, sticky and slightly plastic; common fine roots; common fine and very fine pores; neutral; abrupt smooth boundary.

A—7 to 18 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; few fine faint light olive brown (2.5Y 5/6) mottles; weak fine angular blocky structure; very hard, friable, sticky and slightly plastic; common very fine roots; common very fine pores; neutral; clear irregular boundary.

Bg—18 to 30 inches; dark grayish brown (2.5Y 4/2) silty clay loam, grayish brown (2.5Y 5/2) dry; common medium distinct dark reddish brown (5YR 4/2) mottles; strong medium angular blocky structure; hard, friable, sticky and plastic; few very fine roots; few very fine pores; few small accumulations of iron-manganese; lime disseminated throughout; slight effervescence; mildly alkaline; gradual wavy boundary.

Cg1—30 to 36 inches; olive gray (5Y 4/2) silty clay loam, light olive gray (5Y 6/2) dry; many fine and medium prominent strong brown (7.5YR 5/6) mottles; massive; hard, friable, sticky and plastic; few very fine roots; few very fine pores; few small accumulations of iron-manganese; lime disseminated throughout; slight effervescence; mildly alkaline; gradual wavy boundary.

Cg2—36 to 60 inches; light brownish gray (2.5Y 6/2) silt loam, light gray (2.5Y 7/2) dry; many medium prominent gray (5Y 6/1) mottles; massive; slightly hard, very friable, slightly sticky and slightly plastic; many medium accumulations of iron-manganese; lime disseminated throughout; strong effervescence; moderately alkaline.

The solum ranges from 18 to 36 inches in thickness, and the mollic epipedon ranges from 10 to 24 inches in thickness. Depth to carbonates ranges from 18 to 36 inches. Coarser or finer textured sediments are at a depth below 40 inches in some pedons.

Rauville Series

The Rauville series consists of deep, very poorly drained, moderately slowly permeable soils on flood plains. The soils formed in stratified, moderately fine textured to coarse textured alluvium. The slope is 0 to 1 percent.

Rauville soils are similar to Dovray, Lamoure, and Perella soils and are commonly adjacent to Colvin and

Lamoure soils. Dovray soils contain more clay than Rauville soils. Lamoure soils are poorly drained. Perella soils have a regular decrease in organic matter and are in depressions. Colvin soils have a layer of accumulated lime within a depth of 16 inches. Colvin and Lamoure soils are above the Rauville soils on the landscape.

Typical pedon of Rauville silty clay loam, 480 feet north and 500 feet west of the southeast corner of sec. 18, T. 142 N., R. 53 W.

A1—0 to 10 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; many fine and very fine pores; few fine snail shells; lime disseminated throughout; strong effervescence; moderately alkaline; clear smooth boundary.

A2—10 to 32 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine angular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine and many very fine roots; many fine and very fine pores; lime disseminated throughout; strong effervescence; moderately alkaline; clear smooth boundary.

Cg—32 to 47 inches; gray (10YR 5/1) silty clay loam, light gray (10YR 6/1) dry; few medium prominent strong brown (7.5YR 5/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few fine and very fine pores; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

2C—47 to 60 inches; olive gray (5Y 5/2) stratified sand, gravel, and clay loam, light olive gray (5Y 6/2) dry; common medium distinct light yellowish brown (2.5Y 6/4) mottles; massive; loose, slightly sticky and slightly plastic; lime disseminated throughout; strong effervescence; moderately alkaline.

The mollic epipedon is 24 to 42 inches thick. An O horizon up to 6 inches thick is at the surface in some pedons. The Cg horizon is silty clay loam or silt loam. The 2C horizon is stratified sand, gravel, and clay loam or loam. Some pedons do not have a 2C horizon.

Renshaw Series

The Renshaw series consists of deep, somewhat excessively drained, rapidly permeable soils that are shallow over sand and gravel. They are on glacial outwash plains. The soils formed in medium textured alluvium over sand and gravel. The slope ranges from 1 to 6 percent.

Renshaw soils are commonly adjacent to Barnes, Embden, Sioux, and Svea soils. Barnes soils have a loam C horizon. Embden soils have a 2C horizon at a depth of 40 inches or more and are fine sandy loam and very fine sandy loam above a depth of 40 inches. Barnes soils are on glacial plains. Sioux soils do not have a Bw horizon and are on knobs and ridges. Svea soils do not have a sand and gravel 2C horizon and have a mollic epipedon that is more than 16 inches thick. They are on foot slopes of glacial till plains.

Typical pedon of Renshaw loam, in an area of Renshaw-Sioux loams, 1 to 6 percent slopes, 200 feet south and 2,100 feet east of the northwest corner of sec. 4, T. 140 N., R. 54 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium granular structure; soft, very friable, slightly sticky and slightly plastic; common fine and many very fine roots; many very fine pores; neutral; abrupt smooth boundary.

Bw—7 to 15 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few fine and many very fine roots; many fine and very fine pores; 5 percent coarse fragments; neutral; abrupt wavy boundary.

2C1—15 to 28 inches; dark brown (10YR 4/3) gravelly loamy sand, pale brown (10YR 6/3) dry; single grained; loose, nonsticky, and nonplastic; 30 percent coarse fragments; lime disseminated throughout; strong effervescence; mildly alkaline; gradual wavy boundary.

2C2—28 to 60 inches; brown (10YR 5/3) very gravelly loamy sand, very pale brown (10YR 7/3) dry; single grained; loose, nonsticky and nonplastic; 40 percent coarse fragments; lime disseminated throughout; strong effervescence; mildly alkaline.

The mollic epipedon ranges from 10 to 16 inches in thickness. The thickness of the solum and the depth to sand and gravel range from 14 to 20 inches.

Ryan Series

The Ryan series consists of deep, poorly drained, very slowly permeable, alkali (sodic) soils on glacial lake plains. The soils formed in fine textured lacustrine sediments. The slope is 0 to 1 percent.

Ryan soils are commonly adjacent to Dovray, Fargo, Hegne, and Overly soils. The adjacent soils do not have a natric horizon. Dovray soils are lower on the landscape than the Ryan soils and Hegne and Overly soils are higher.

Typical pedon of Ryan silty clay, in an area of Fargo-Ryan silty clays, 2,465 feet south and 2,450 feet east of the northwest corner of sec. 22, T. 137 N., R. 50 W.

Ap—0 to 4 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; very hard, firm, very sticky and very

plastic; many fine and very fine roots; common very fine pores; mildly alkaline; clear smooth boundary.

Btz1—4 to 10 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate medium prismatic structure parting to strong very fine angular blocky; hard, firm, very sticky and very plastic; many very fine roots; many very fine pores; few thin clay films on faces of peds; slight effervescence; common fine salt nests; mildly alkaline; clear smooth boundary.

Btz2—10 to 15 inches; dark olive gray (5Y 3/2) clay, olive gray (5Y 4/2) dry; moderate medium prismatic structure parting to strong very fine angular blocky; very hard, firm, very sticky and very plastic; common very fine roots; common very fine pores; few thin clay films on faces of peds; many fine salt nests; slight effervescence; moderately alkaline; clear wavy boundary.

Czg1—15 to 29 inches; very dark gray (5Y 3/1) silty clay, gray (5Y 5/1) dry; moderate very fine angular blocky structure; very hard, firm, very sticky and very plastic; few very fine roots; common very fine pores; common fine salt nests; lime disseminated throughout; strong effervescence; moderately alkaline; gradual wavy boundary.

Czg2—29 to 60 inches; olive gray (5Y 4/2) silty clay, light olive gray (5Y 6/2) dry; few fine distinct black (10YR 2/1) mottles; moderate fine subangular blocky structure; very hard, firm, very sticky and very plastic; few very fine pores; common fine salt nests; lime disseminated throughout; strong effervescence; strongly alkaline.

The solum ranges from 5 to 16 inches in thickness and the mollic epipedon ranges from 20 to 48 inches. The Btz horizon is clay or silty clay.

Sioux Series

The Sioux series consists of deep, excessively drained, rapidly permeable soils that are very shallow over sand and gravel. They are on glacial outwash plains and beach ridges. The soils formed in coarse textured glacial outwash. The slope ranges from 1 to 15 percent.

Sioux soils are commonly adjacent to Barnes, Buse, Embden, and Renshaw soils. Barnes and Buse soils have a loam or clay loam substratum. Embden soils have a mollic epipedon more than 16 inches thick. Renshaw soils have a Bw horizon. Barnes and Embden soils are below the Sioux soils on the landscape.

Typical pedon of Sioux loam, in an area of Renshaw-Sioux loams, 1 to 6 percent slopes, 300 feet south and 2,100 feet east of the northwest corner of sec. 4, T. 140 N., R. 54 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium granular structure; soft, very friable, slightly sticky and slightly plastic; common fine and many very fine roots; many very fine pores; neutral; abrupt smooth boundary.

AC—7 to 11 inches; brown (10YR 3/3) gravelly loamy sand, dark brown (10YR 4/3) dry; weak medium subangular blocky structure; loose, nonsticky and nonplastic; few fine and many very fine roots; many fine and very fine pores; lime disseminated throughout; 25 percent coarse fragments; slight effervescence; mildly alkaline; abrupt wavy boundary.

C—11 to 60 inches; grayish brown (10YR 5/2) and brown (10YR 5/3) extremely gravelly sand, light gray (10YR 7/2) and pale brown (10YR 6/3) dry; single grained; loose; 70 percent coarse fragments; lime disseminated throughout; strong effervescence; moderately alkaline.

The depth to sand and gravel ranges from 6 to 14 inches. The mollic epipedon ranges from 7 to 14 inches in thickness. The A horizon is loam or gravelly sandy loam. The C horizon is gravelly sand, gravelly loamy sand, or extremely gravelly sand. Coarse fragments make up 25 to 90 percent of the volume.

Svea Series

The Svea series consists of deep, moderately well drained, moderately slowly permeable soils on glacial till plains. The soils formed in medium textured glacial till. The slope ranges from 0 to 6 percent.

The Svea soils are similar to Emrick, Gardena, and Overly soils and commonly are adjacent to Barnes, Buse, Hamerly, and Wyard soils. Emrick soils have less clay than the Svea soils, and Gardena and Overly soils have less sand. Barnes and Buse soils have a mollic epipedon that is less than 16 inches thick. They are above the Svea soils on the landscape. The Buse soils are on knobs and steep side slopes. The Hamerly soils have a layer of accumulated lime within 16 inches of the surface. They are below the Svea soils on the landscape. The Wyard soils are somewhat poorly drained and are on toe slopes.

Typical pedon of Svea loam (fig. 22), in an area of Svea-Buse loams, 3 to 6 percent slopes, 60 feet south and 345 feet east of the northwest corner of sec. 18, T. 139 N., R. 54 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium granular structure; hard, friable, slightly sticky and slightly plastic; common medium and fine roots; common medium and fine pores; neutral; abrupt smooth boundary.

A—10 to 18 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium and fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common medium and fine

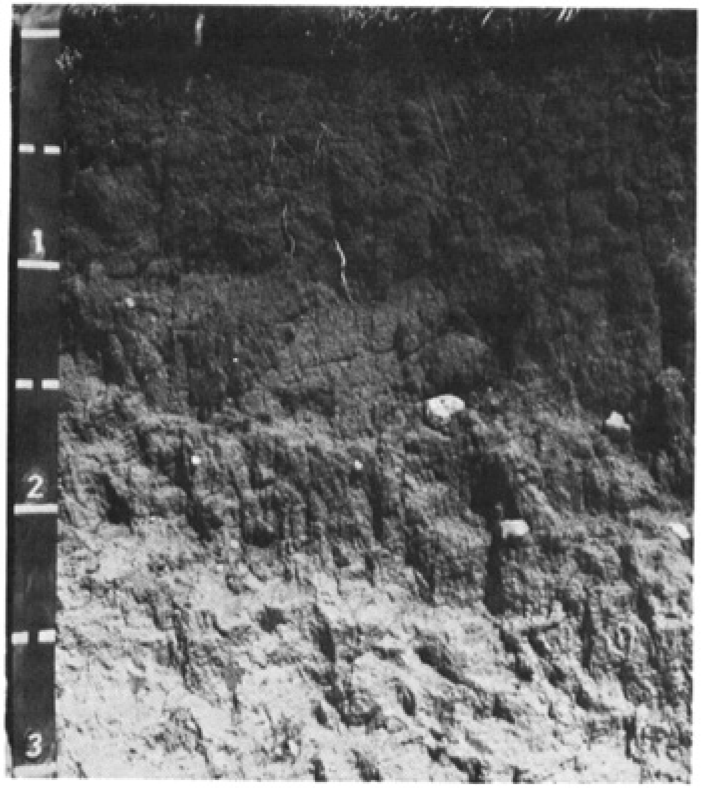

Figure 22.—The black surface layer of this Svea loam is about 18 inches thick. The lime-free subsoil extends to a depth of about 28 inches, below which is a layer of accumulated lime. The pebbles are a part of the glacial till in which the Svea soils formed.

roots; common medium and fine pores; neutral; abrupt smooth boundary.

Bw—18 to 28 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; few medium and common fine roots; common fine and medium pores; neutral; clear wavy boundary.

Bk—28 to 43 inches; light yellowish brown (2.5Y 6/4) loam, light gray (2.5Y 7/2) dry; massive; hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine pores; about 5 percent coarse fragments; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—43 to 48 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; massive, hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine pores; about 5 percent coarse fragments; lime disseminated throughout; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—48 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; common medium distinct white (N 8/0) and few fine distinct reddish yellow (7.5YR 6/8) mottles; massive; hard, friable, slightly sticky and slightly plastic; few very fine roots; few fine and common very fine pores; about 5 percent coarse fragments; lime disseminated throughout; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 16 to more than 30 inches in thickness, and the solum ranges from 20 to 36 inches.

Tiffany Series

The Tiffany series consists of deep, poorly drained, moderately permeable soils on deltas, on glacial lake plains, and on glacial outwash plains. The soils formed in medium textured to coarse textured glacial outwash sediment and lacustrine sediment. The slope is 0 to 1 percent.

The Tiffany soils commonly are adjacent to Embden, Galchutt, Gardena, Glyndon, and Wyndmere soils. Embden and Gardena soils are moderately well drained. Galchutt soils are somewhat poorly drained and have a subsurface layer that is light in color. Glyndon and Wyndmere soils have a layer of accumulated lime within a depth of 16 inches. All the adjacent soils are higher on the landscape than the Tiffany soils.

Typical pedon of Tiffany silt loam, in an area of Glyndon-Tiffany silt loams, 0 to 3 percent slopes, 1,790 feet east and 1,405 feet north of the southwest corner of sec. 29, T. 137 N., R. 51 N.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine and many very fine roots; common medium and many fine and very fine pores; neutral; abrupt smooth boundary.

A—8 to 13 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to moderate fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many fine and very fine pores; neutral; gradual wavy boundary.

AC—13 to 22 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; common fine and very fine

pores; few fine black concretions of iron-manganese; neutral; clear wavy boundary.

C1—22 to 36 inches; light olive brown (2.5Y 5/4) very fine sandy loam, pale yellow (2.5Y 7/4) dry; few coarse distinct black (5Y 2/1) mottles; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; common fine and many very fine pores; few fine black concretions of iron-manganese; slight effervescence; mildly alkaline; abrupt smooth boundary.

C2—36 to 60 inches; light brownish gray (2.5Y 6/2) silt loam, light gray (2.5Y 7/2) dry; few medium prominent strong brown (7.5YR 5/8) mottles; weak fine subangular blocky structure; hard, very friable, sticky and slightly plastic; few very fine roots; many fine and very fine pores; few fine black concretions of iron-manganese; slight effervescence; mildly alkaline.

The mollic epipedon ranges from 10 to 24 inches in thickness. The A horizon is loam or silt loam. In some pedons there is no AC horizon. The C2 horizon is fine sand, silt loam, or loam.

Tonka Series

The Tonka series consists of deep, poorly drained, slowly permeable soils on glacial till plains. The soils formed in local alluvium and medium textured and moderately fine textured glacial till. The slope is 0 to 1 percent.

Tonka soils are similar to Lindaas soils and commonly are adjacent to Hamerly, Parnell, Vallers, and Wyard soils. Lindaas and Parnell soils do not have an albic horizon. Hamerly and Vallers soils have a layer of accumulated lime within a depth of 16 inches. They are higher on the landscape than the Tonka soils. Parnell soils are in deep depressions. Wyard soils do not have an argillic horizon or an albic horizon. They are immediately above Tonka soils on the landscape.

Typical pedon of Tonka silt loam, 800 feet south and 2,640 feet east of the northwest corner of sec. 14, T. 141 N., R. 54 W.

A—0 to 7 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure parting to moderate medium granular; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; many fine and very fine pores; neutral; abrupt smooth boundary.

E1—7 to 11 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; strong thin platy structure; soft, very friable, slightly sticky and slightly plastic; many fine and very fine roots; common fine and very fine pores; neutral; clear wavy boundary.

E2—11 to 15 inches; grayish brown (10YR 5/2) loam, light brownish gray (10YR 6/2) dry; few medium distinct dark yellowish brown (10YR 3/4) mottles; strong thin platy structure; soft, very friable, slightly sticky and slightly plastic; common fine and very fine roots; common fine and very fine pores; neutral; clear irregular boundary.

Bt—15 to 23 inches; very dark grayish brown (2.5Y 3/2) silty clay loam, dark grayish brown (2.5Y 4/2) dry; common medium distinct dark yellowish brown (10YR 3/6) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; common fine roots; common very fine pores; thin clay films on surface of peds; neutral; clear wavy boundary.

BC—23 to 40 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; few medium distinct strong brown (7.5YR 5/6) and dark yellowish brown (10YR 3/6) mottles; weak thick platy structure parting to moderate fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine pores; neutral; gradual wavy boundary.

Cg1—40 to 46 inches; grayish brown (2.5Y 5/2) clay loam, light brownish gray (2.5Y 6/2) dry; many coarse prominent strong brown (7.5YR 5/6) and dark yellowish brown (10YR 3/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; neutral; gradual wavy boundary.

Cg2—46 to 60 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; common medium prominent strong brown (7.5YR 5/6) and few coarse distinct brown (10YR 5/3) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; slight effervescence; mildly alkaline.

The depth to carbonates ranges from 28 to 60 inches. The A horizon is loam or silt loam. Mottles in the E2 horizon range from few to many, fine to coarse, and faint to prominent. The Bt horizon is clay loam, silty clay loam, silty clay, or clay. The C horizon is loam, clay loam, or silty clay loam. In some pedons, coarse fragments make up 2 to 10 percent of the BC and Cg horizons.

Vallers Series

The Vallers series consists of deep, poorly drained, moderately slowly permeable soils on glacial till plains. The soils formed in moderately fine textured and medium textured glacial till. The slope is 0 to 1 percent.

Vallers soils are similar to Colvin and Hegne soils and commonly are adjacent to Hamerly, Wyard, and Tonka soils. Colvin soils contain less sand and more silt than the Vallers soils, and Hegne soils contain more clay. Hamerly soils are somewhat poorly drained and are above the Vallers soils on the landscape. Wyard soils do

not have a layer of accumulated lime within a depth of 16 inches. They are on foot slopes and toe slopes. Tonka soils have an albic horizon and an argillic horizon. They are in depressions.

Typical pedon of Vallers loam, 700 feet south and 120 feet west of the northeast corner of sec. 10, T. 141 N., R. 55 W.

Ap—0 to 7 inches; black (N 2/0) loam, black (10YR 2/1) dry; moderate coarse subangular blocky structure parting to moderate medium subangular blocky; slightly hard, firm, sticky and plastic; many medium roots; many medium pores; lime disseminated throughout; strong effervescence; moderately alkaline; abrupt smooth boundary.

AB—7 to 11 inches; very dark grayish brown (2.5Y 3/2) and very dark gray (10YR 3/1) loam, dark grayish brown (2.5Y 4/2) and dark gray (10YR 4/1) dry; moderate coarse subangular blocky structure; slightly hard, firm, sticky and plastic; many fine roots; many fine and very fine pores; lime disseminated throughout; strong effervescence; moderately alkaline; gradual wavy boundary.

Bkg—11 to 18 inches; dark gray (5Y 4/1) loam, gray (5Y 5/1) dry; weak coarse subangular blocky structure; slightly hard, friable, sticky and plastic; common fine roots; common fine and very fine pores; common fine salt masses; lime disseminated throughout; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg1—18 to 28 inches; olive gray (5Y 5/2) clay loam, light gray (5Y 7/2) dry; massive; slightly hard, firm, sticky and plastic; common fine roots; common fine and very fine pores; few fine salt masses; lime disseminated throughout; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg2—28 to 38 inches; olive gray (5Y 5/2) clay loam, light gray (5Y 7/2) dry; common medium distinct yellowish brown (10YR 5/6) mottles; massive; hard, firm, sticky and plastic; common fine roots; common fine and very fine pores; 2 percent coarse fragments; few fine salt masses; lime disseminated throughout; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg3—38 to 60 inches; olive gray (5Y 5/2) clay loam, light gray (5Y 7/2) dry; few medium faint gray (5Y 5/1) and many medium distinct brown (7.5YR 4/4) mottles; massive; hard, firm, sticky and plastic; few fine roots; common fine and very fine pores; 2 percent coarse fragments; few fine salt masses; lime disseminated throughout; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 7 to 24 inches in thickness. In some pedons, Vallers soils are saline. In some pedons, there are mottles in the lower part of the A horizon. In some pedons, coarse fragments make up 2 to 10 percent of the Cg1 horizon. The Cg horizon is loam or clay loam.

Wahpeton Series

The Wahpeton series consists of deep, moderately well drained, moderately slowly permeable soils on flood plains and on terraces. The soils formed in fine textured alluvium. The slope is 0 to 1 percent.

Wahpeton soils are commonly adjacent to Cashel, Fargo, and Nutley soils. Cashel soils do not have a mollic epipedon and are below the Wahpeton soils on the flood plains. Fargo soils are poorly drained. Nutley soils have a mollic epipedon less than 16 inches thick. The Fargo and Nutley soils are higher on the landscape than the Wahpeton soils.

Typical pedon of Wahpeton silty clay, 225 feet south and 2,600 feet east of the northwest corner of sec. 30, T. 138 N., R. 49 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to weak fine subangular blocky; slightly hard, friable, sticky and plastic; common fine and very fine roots; common fine and many very fine pores; neutral; abrupt smooth boundary.

A1—9 to 21 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to weak fine subangular blocky; hard, friable, sticky and plastic; common coarse, medium, and fine roots; common coarse, medium, and fine pores; neutral; clear smooth boundary.

A2—21 to 33 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; weak coarse prismatic structure parting to medium and fine subangular blocky; hard, friable, sticky and plastic; common coarse, medium, and fine roots; common coarse, medium, and fine pores; lime disseminated throughout; violent effervescence; mildly alkaline; gradual wavy boundary.

C—33 to 48 inches; dark grayish brown (2.5Y 4/2) and very dark grayish brown (2.5Y 3/2) silty clay, light brownish gray (2.5Y 6/2) and grayish brown (2.5Y 5/2) dry; weak coarse prismatic structure parting to weak medium and fine subangular blocky; hard, friable, sticky and plastic; common coarse and medium and few fine roots; common coarse and medium and few fine pores; lime disseminated throughout; slight effervescence; mildly alkaline; gradual wavy boundary.

Ab—48 to 60 inches; dark olive gray (5Y 3/2) silty clay, olive gray (5Y 5/2) dry; weak coarse prismatic structure parting to weak coarse subangular blocky; hard, friable, sticky and plastic; common medium

roots; common medium pores; many fine threads of lime; slight effervescence; mildly alkaline.

The mollic epipedon ranges from 16 to 40 inches in thickness. The Ab horizon and the C horizon are clay, silty clay, or silty clay loam. In most pedons, when dry, cracks extend from the surface to a depth of 60 inches or more.

Wyard Series

The Wyard series consists of deep, somewhat poorly drained, moderately permeable soils on glacial till plains. The soils formed in medium textured local alluvium and in glacial till. The slope ranges from 1 to 3 percent.

Wyard soils are commonly adjacent to Hamerly, Svea, Tonka, and Vallers soils. Hamerly and Vallers soils have a layer of accumulated lime within a depth of 16 inches. They are higher on the landscape than the Wyard soils. Svea soils are moderately well drained. They also are higher on the landscape than the Wyard soils. Tonka soils have an argillic horizon. They are in shallow depressions.

Typical pedon of Wyard loam, in an area of Wyard-Hamerly loams, 1 to 3 percent slopes, 2,400 feet north and 750 feet east of the southwest corner of sec. 3, T. 141 N., R. 54 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak, medium subangular blocky structure parting to weak fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; common fine and very fine pores; neutral; abrupt smooth boundary.

A—6 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; few fine faint dark grayish brown (10YR 4/2) mottles; weak medium subangular blocky structure parting to weak fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; common fine and very fine pores; neutral; clear wavy boundary.

Bw1—10 to 16 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; common fine distinct dark yellowish brown (10YR 4/4) and strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; common fine and very fine pores; clean silt and sand grains on faces of peds; slight effervescence; mildly alkaline; gradual wavy boundary.

Bw2—16 to 22 inches; very dark grayish brown (2.5Y 3/2) loam, dark grayish brown (2.5Y 4/2) dry; common fine distinct dark yellowish brown (10YR 4/4) and brown (7.5YR 5/4) mottles; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine pores; few fine threads of lime in lower part of horizon; slight effervescence; mildly alkaline; gradual wavy boundary.

Bk—22 to 28 inches; light brownish gray (2.5Y 6/2) loam, light gray (2.5Y 7/2) dry; few fine distinct olive yellow (2.5Y 6/6) mottles; massive; soft, very friable, slightly sticky and slightly plastic; common very fine pores; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—28 to 47 inches; pale olive (5Y 6/3) loam, pale yellow (5Y 7/3) dry; common fine distinct light olive brown (2.5Y 5/4) and prominent strong brown (7.5YR 5/6) mottles; massive; hard, friable, slightly sticky and slightly plastic; few very fine pores; about 5 percent coarse fragments; lime disseminated throughout; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—47 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct light brownish gray (2.5Y 6/2) and prominent strong brown (7.5YR 5/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine pores; about 5 percent coarse fragments; lime disseminated throughout; strong effervescence; moderately alkaline.

The solum ranges from 22 to 42 inches in thickness, and the mollic epipedon ranges from 16 to 24 inches. The Bw horizon is loam or silt loam. The C horizon is loam or clay loam.

Wyndmere Series

The Wyndmere series consists of deep, somewhat poorly drained, moderately rapidly permeable soils on glacial lake plains. The soils formed in moderately coarse textured, coarse textured, and medium textured lacustrine sediments. The slope ranges from 0 to 6 percent.

Wyndmere soils are similar to Glyndon and Hamerly soils and commonly are adjacent to Embden, Gardena, Glyndon, Hamerly, and Tiffany soils. Glyndon soils contain less sand and more silt than the Wyndmere soils, and Hamerly soils contain more clay. Embden and Gardena soils do not have a layer of accumulated lime within a depth of 16 inches. They are above the Wyndmere soils on the landscape. Tiffany soils are poorly drained. They are below the Wyndmere soils on the landscape.

Typical pedon of Wyndmere loam, in an area of Wyndmere-Tiffany loams, 0 to 3 percent slopes, 930 feet south and 2,000 feet west of the northeast corner of sec. 32, T. 142 N., R. 55 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to weak fine subangular blocky; soft, very friable, slightly sticky and nonplastic; common fine and very fine roots; few fine and common very fine pores; lime disseminated throughout; strong effervescence; moderately alkaline; abrupt smooth boundary.

Ak—8 to 14 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak moderate subangular blocky structure parting to weak fine subangular blocky; slightly hard, very friable, slightly sticky and nonplastic; common fine and very fine roots; few fine and common very fine pores; lime disseminated throughout; strong effervescence; moderately alkaline; diffuse wavy boundary.

Bk—14 to 23 inches; grayish brown (2.5Y 5/2) fine sandy loam, light gray (2.5Y 7/2) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; very weak subangular blocky structure; soft, very friable, slightly sticky and nonplastic; few fine and very fine roots; few very fine pores; lime disseminated throughout; violent effervescence; moderately alkaline; diffuse wavy boundary.

C1—23 to 45 inches; dark yellowish brown (10YR 4/4) fine sandy loam, yellowish brown (10YR 5/4) dry; few fine faint light brownish gray (2.5Y 6/2) and brown (7.5YR 5/4) mottles; massive; loose, nonsticky and nonplastic; few fine and very fine roots; few very fine pores; lime disseminated throughout; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—45 to 60 inches; multicolored fine sandy loam; massive; loose, nonsticky and nonplastic; few very fine pores; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 7 to 16 inches in thickness. The A horizon is loam or silt loam. The Bk horizon has few to many faint or distinct mottles. The C1 horizon is loam, silt loam, fine sandy loam, or loamy fine sand. In some pedons, the C2 horizon is clay or loamy sand.

Survey Procedures

The general procedures followed in making this survey are described in the National Soils Handbook of the Soil Conservation Service. The references consulted are listed in this publication.

Before the actual field mapping began, topographic maps at a scale of 1:24,000 were cut to the same boundaries as the soil survey field sheets. The soil survey field sheets were printed at 1:20,000 from 1976 aerial photographs flown at a scale of 1:48,000. The topographic maps were used along with the aerial photographs to more accurately locate map unit boundaries.

Traverses were made on foot, by pickup truck with mounted bull probe, and by three-wheel all-terrain vehicles at an interval close enough to locate contrasting soil areas of about 3 to 4 acres. All map units were characterized by transecting representative map units. One transect was required for each 1,000 acres of the map unit with a minimum of 2 transects and a maximum of about 10. Additional transects were recorded for some map units to justify names and establish the range of composition of the unit. For each map unit, the minimum documentation consisted of three pedon descriptions for each soil series used in its name.

Laboratory data for more than 30 pedons sampled and characterized during the period 1950-66 were available for Cass County. Some of the pedons were sampled in the area of Cass County that was included in the soil survey of the Tri-County Area *(13)*. In 1979, an additional 12 pedons were sampled for characterization and engineering properties. The soils analyses were made by the North Dakota State University Soil Characterization Laboratory and by the North Dakota State Highway Department.

The problem of septic tank failure on the Fargo, Hegne, and Ryan soils lead to a research project on septic tank absorption field suitability by Jay F. Conta *(4)*. The project resulted in a new method to predict and assess soil suitability for septic tank absorption fields.

After completion of the soil mapping, the survey was correlated and the map delineations were transferred for publication by hand to overlays at a scale of 1:20,000.

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Glossary

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Fine textured soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C

horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Lacustrine sediment (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Salty water (in tables.) Water that is too salty for consumption by livestock.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multipled by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Splay (flood plain). A small alluvial fan or other outspread deposit that formed when a stream broke through a levee and deposited sediment.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-78 at Amenia, North Dakota]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	15.6	-5.1	5.3	43	-32	0	0.33	0.12	0.50	1	6.5
February---	23.6	2.4	13.0	48	-27	0	.33	.11	.50	2	5.0
March------	35.8	15.6	25.7	64	-19	42	.71	.22	1.09	2	5.2
April------	54.5	31.5	43.0	84	10	175	2.03	.98	2.93	5	3.2
May--------	70.1	42.7	56.4	91	24	508	2.74	1.33	3.96	6	.0
June-------	78.4	52.5	65.5	96	36	765	3.68	1.76	5.34	7	.0
July-------	84.0	57.1	70.5	98	42	946	3.09	1.21	4.66	5	.0
August-----	83.3	55.3	69.3	101	39	908	2.63	1.38	3.72	6	.0
September--	72.5	45.1	58.8	95	25	564	2.15	.62	3.38	4	.0
October----	60.4	35.0	47.7	88	13	267	1.30	.37	2.04	3	.5
November---	38.7	19.4	29.1	68	-10	24	.68	.14	1.09	2	3.8
December---	23.0	3.7	13.3	48	-27	10	.50	.20	.75	2	6.7
Yearly:											
Average--	53.3	30.0	41.5	---	---	---	---	---	---	---	---
Extreme--	---	---	---	101	-33	---	---	---	---	---	---
Total----	---	---	---	---	---	4,209	20.17	15.82	24.26	45	30.9

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-78 at Amenia, North Dakota]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 8	May 17	May 25
2 years in 10 later than--	May 2	May 12	May 21
5 years in 10 later than--	April 21	May 2	May 14
First freezing temperature in fall:			
1 year in 10 earlier than--	September 30	September 15	September 12
2 years in 10 earlier than--	October 5	September 20	September 16
5 years in 10 earlier than--	October 16	September 30	September 23

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-78 at Amenia, North Dakota]

Probability	Length of growing season if daily minimum temperature is--		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	152	130	117
8 years in 10	160	137	122
5 years in 10	177	150	132
2 years in 10	193	163	142
1 year in 10	201	170	147

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
1	Fargo-Enloe silty clays	9,300	1.0
2	Tonka silt loam	2,520	0.3
3	Parnell silty clay loam	2,980	0.3
4	Perella silty clay loam	1,080	0.1
5	Dovray silty clay	5,000	0.5
6	Parnell silty clay loam, ponded	2,000	0.2
9C	Nutley-Fargo silty clays, 1 to 9 percent slopes	3,170	0.3
10	Fargo-Ryan silty clays	25,160	2.8
11	Nahon silt loam, 0 to 2 percent slopes	1,990	0.2
12	Hegne-Enloe silty clays	3,820	0.4
14B	Barnes-Buse loams, 3 to 6 percent slopes	22,280	2.4
14C	Barnes-Buse loams, 6 to 9 percent slopes	8,370	0.9
14D	Barnes-Buse loams, 9 to 15 percent slopes	990	0.1
15	Emrick-Heimdal loams, 1 to 3 percent slopes	1,410	0.2
15B	Heimdal-Emrick loams, 3 to 6 percent slopes	3,580	0.4
15C	Heimdal-Esmond loams, 6 to 9 percent slopes	2,250	0.2
15D	Esmond-Heimdal loams, 9 to 15 percent slopes	1,040	0.1
16B	Barnes-Sioux loams, 3 to 6 percent slopes	3,510	0.4
16C	Barnes-Sioux loams, 6 to 9 percent slopes	2,280	0.2
16D	Barnes-Sioux loams, 9 to 15 percent slopes	410	*
17B	Barnes-Svea loams, 2 to 5 percent slopes	35,650	3.9
18	Bearden silty clay loam	14,510	1.6
19	Colvin silty clay loam, saline	6,550	0.7
20	Bearden silty clay loam, saline	6,780	0.7
22	Bearden-Perella silty clay loams	28,340	3.1
23F	Buse-Barnes loams, 15 to 35 percent slopes	1,980	0.2
24	Cashel silty clay	4,010	0.4
25	Cashel silty clay, channeled	4,590	0.5
26	Colvin silty clay loam	6,730	0.7
27	Divide loam	1,070	0.1
29	Fargo silty clay, saline	2,190	0.2
31B	Embden fine sandy loam, gravelly substratum, 1 to 6 percent slopes	6,250	0.7
32	Fargo silty clay, 1 to 3 percent slopes	4,200	0.5
35	Fairdale silt loam, 1 to 3 percent slopes	3,600	0.4
36	Fargo silty clay	186,200	20.4
37	Fargo silty clay, depressional	31,560	3.5
38	Fargo silty clay loam	28,530	3.1
39	Galchutt silt loam	5,450	0.6
40	Fargo-Hegne silty clays	99,220	10.9
41	Hegne-Fargo silty clay loams	24,700	2.7
43	Gardena silt loam	5,680	0.6
46	Gardena-Glyndon silt loams, 0 to 3 percent slopes	4,190	0.5
47	Fargo silty clay, smooth surface	3,130	0.3
48	Glyndon silt loam, 0 to 3 percent slopes	7,310	0.8
49	Glyndon silt loam, saline, 0 to 3 percent slopes	2,660	0.3
50	Hamerly-Tonka loams, 0 to 3 percent slopes	65,810	7.2
50B	Hamerly loam, 3 to 6 percent slopes	2,260	0.2
51	Hamerly loam, saline, 0 to 3 percent slopes	3,700	0.4
54	Lamoure silty clay loam	3,820	0.4
55	LaDelle silty clay loam	2,320	0.3
57	Fairdale silt loam, channeled	5,900	0.6
58B	Maddock fine sandy loam, 1 to 6 percent slopes	520	0.1
59	Overly silty clay loam, 0 to 3 percent slopes	6,100	0.7
59B	Overly silty clay loam, 3 to 6 percent slopes	1,150	0.1
61	Perella-Bearden silty clay loams	33,660	3.7
62	Overly-Bearden silt loams, 0 to 3 percent slopes	10,150	1.1
63B	Renshaw-Sioux loams, 1 to 6 percent slopes	4,460	0.5
63C	Sioux gravelly sandy loam, 3 to 9 percent slopes	400	*
64	Pits, gravel	410	*
65	Svea-Barnes loams, 0 to 2 percent slopes	30,860	3.4
66	Wyard-Hamerly loams, 1 to 3 percent slopes	30,070	3.3
67	Galchutt fine sandy loam	4,660	0.5
71	Vallers loam	8,750	1.0
72	Wahpeton silty clay	1,590	0.2
73	Rauville silty clay loam	2,900	0.3
76	Wyndmere silt loam, 0 to 3 percent slopes	1,770	0.2
76B	Wyndmere silt loam, undulating	2,060	0.2
77	Vallers loam, saline	5,050	0.6
78B	Svea-Buse loams, 3 to 6 percent slopes	8,110	0.9
80	Wyndmere-Tiffany loams, 0 to 3 percent slopes	6,720	0.7

See footnote at end of table.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
82	Glyndon-Tiffany silt loams, 0 to 3 percent slopes	17,000	1.9
83	Galchutt-Fargo silty clay loams	10,780	1.2
84	Bearden-Lindaas silty clay loams	11,330	1.2
85	Fairdale Variant silt loam	1,040	0.1
	Water	1,710	0.2
	Total	913,280	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Soybeans	Sunflower	Sugar beets	Spring wheat	Barley	Corn	Grass-legume hay
	Bu	Lbs	Tons	Bu	Bu	Bu	Tons
1: Fargo-Enloe	28	1,600	17	36	61	---	3.0
2: Tonka	---	1,500	---	30	51	70	2.2
3: Parnell	---	1,500	---	27	46	65	1.8
4: Perella	24	1,700	---	34	58	70	2.7
5: Dovray	22	1,600	12	32	54	65	2.6
6: Parnell	---	---	---	---	---	---	---
9C: Nutley-Fargo	20	1,400	---	31	53	70	2.5
10: Fargo-Ryan	19	1,200	---	31	53	57	2.7
11: Nahon	---	1,100	---	24	40	---	2.0
12: Hegne-Enloe	26	1,500	16	35	60	---	2.8
14B: Barnes-Buse	24	1,400	---	29	49	60	2.4
14C: Barnes-Buse	21	1,200	---	24	41	50	2.1
14D: Barnes-Buse	---	---	---	19	33	---	1.8
15: Emrick-Heimdal	28	1,650	---	33	56	75	2.8
15B: Heimdal-Emrick	23	1,400	---	26	44	67	2.1
15C: Heimdal-Esmond	---	1,000	---	19	32	45	1.5
15D: Esmond-Heimdal	---	---	---	---	---	---	---
16B: Barnes-Sioux	---	1,100	---	23	39	47	1.9
16C: Barnes-Sioux	---	---	---	17	29	---	1.5
16D: Barnes-Sioux	---	---	---	---	---	---	---
17B: Barnes-Svea	27	1,600	---	33	56	75	2.6
18: Bearden	29	1,900	18	43	73	85	3.5

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Soybeans	Sunflower	Sugar beets	Spring wheat	Barley	Corn	Grass-legume hay
	Bu	Lbs	Tons	Bu	Bu	Bu	Tons
19------------------------ Colvin	---	900	---	20	47	---	1.7
20------------------------ Bearden	---	1,150	---	26	51	---	2.2
22------------------------ Bearden-Perella	30	1,900	19	43	73	85	3.5
23F----------------------- Buse-Barnes	---	---	---	---	---	---	---
24------------------------ Cashel	28	1,800	14	38	65	80	3.0
25------------------------ Cashel	---	---	---	---	---	---	3.0
26------------------------ Colvin	22	1,600	---	33	56	65	2.7
27------------------------ Divide	---	1,100	---	28	48	65	2.0
29------------------------ Fargo	---	1,250	---	31	60	---	2.6
31B----------------------- Embden	---	1,400	---	28	48	65	2.3
32------------------------ Fargo	32	2,000	18	43	73	83	3.5
35------------------------ Fairdale	30	1,900	18	40	68	90	3.5
36------------------------ Fargo	30	1,900	18	41	70	80	3.2
37------------------------ Fargo	28	1,600	17	38	65	73	2.8
38------------------------ Fargo	33	2,000	20	45	76	85	3.5
39------------------------ Galchutt	31	1,900	18	41	70	90	3.2
40------------------------ Fargo-Hegne	29	1,900	18	41	70	80	3.2
41------------------------ Hegne-Fargo	28	1,900	18	40	68	80	3.2
43------------------------ Gardena	33	2,000	19	43	73	100	3.2
46------------------------ Gardena-Glyndon	31	1,950	18	43	73	95	3.2
47------------------------ Fargo	33	2,000	19	43	73	83	3.5
48------------------------ Glyndon	29	1,900	17	43	73	90	3.5
49------------------------ Glyndon	---	1,150	---	26	51	---	2.2
50------------------------ Hamerly-Tonka	---	1,500	---	32	51	70	2.5

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Soybeans	Sunflower	Sugar beets	Spring wheat	Barley	Corn	Grass-legume hay
	Bu	Lbs	Tons	Bu	Bu	Bu	Tons
50B----------------------- Hamerly	---	1,450	---	29	49	65	2.5
51------------------------ Hamerly	---	950	---	18	42	---	1.6
54------------------------ Lamoure	---	---	---	22	37	---	2.5
55------------------------ LaDelle	33	2,000	20	43	73	100	3.5
57------------------------ Fairdale	---	---	---	---	---	---	3.0
58B----------------------- Maddock	---	---	---	20	34	45	1.9
59------------------------ Overly	33	2,000	20	45	76	100	3.5
59B----------------------- Overly	31	1,800	18	43	73	90	3.5
61------------------------ Perella-Bearden	32	2,000	20	45	76	90	3.5
62------------------------ Overly-Bearden	32	1,950	19	43	73	93	3.5
63B----------------------- Renshaw-Sioux	---	---	---	17	29	---	1.4
63C----------------------- Sioux	---	---	---	---	---	---	---
64*. Pits							
65------------------------ Svea-Barnes	29	1,750	---	35	60	80	2.8
66------------------------ Wyard-Hamerly	---	1,600	---	33	54	70	2.8
67------------------------ Galchutt	29	1,800	16	38	65	90	3.2
71------------------------ Vallers	---	1,200	---	28	48	55	2.2
72------------------------ Wahpeton	31	2,000	19	43	73	85	3.5
73------------------------ Rauville	---	---	---	---	---	---	---
76------------------------ Wyndmere	29	1,900	17	38	65	85	3.5
76B----------------------- Wyndmere	26	1,750	---	35	60	---	3.2
77------------------------ Vallers	---	800	---	17	39	---	1.5
78B----------------------- Svea-Buse	25	1,450	---	30	51	65	2.5
80------------------------ Wyndmere-Tiffany	29	1,750	17	38	65	80	3.5

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Soybeans	Sunflower	Sugar beets	Spring wheat	Barley	Corn	Grass-legume hay
	Bu	Lbs	Tons	Bu	Bu	Bu	Tons
82------------------------- Glyndon-Tiffany	30	1,800	17	40	68	83	3.5
83------------------------- Galchutt-Fargo	31	1,900	18	40	68	85	3.2
84------------------------- Bearden-Lindaas	29	1,900	18	40	68	80	3.0
85------------------------- Fairdale Variant	30	1,900	18	40	68	90	3.2

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
1*:					
Fargo	---	Redosier dogwood, American plum, Siberian peashrub, Tatarian honeysuckle, common chokecherry, eastern redcedar, lilac.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
Enloe	---	Redosier dogwood, common chokecherry, Siberian peashrub, eastern redcedar, lilac, Tatarian honeysuckle, American plum.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
2 Tonka	---	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub, American plum.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
3. Parnell					
4 Perella	---	Lilac, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
5 Dovray	American plum	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
6. Parnell					
9C*:					
Nutley	Tatarian honeysuckle, Peking cotoneaster.	Russian-olive, eastern redcedar, common chokecherry, silver buffaloberry, Siberian peashrub, lilac.	Green ash, Siberian elm, ponderosa pine, Siberian crabapple.	---	---

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
9C*:					
Fargo	---	Redosier dogwood, American plum, Siberian peashrub, Tatarian honeysuckle, common chokecherry, eastern redcedar, lilac.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
10*:					
Fargo	---	Redosier dogwood, American plum, Siberian peashrub, Tatarian honeysuckle, common chokecherry, eastern redcedar, lilac.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
Ryan	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian-olive, eastern redcedar.	---	---	---
11 Nahon	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian-olive, eastern redcedar.	---	---	---
12*:					
Hegne	American plum	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
Enloe	---	Redosier dogwood, common chokecherry, Siberian peashrub, eastern redcedar, lilac, Tatarian honeysuckle, American plum.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
14B*, 14C*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Buse	Siberian peashrub, Tatarian honeysuckle, lilac.	Ponderosa pine, Russian-olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm, green ash.	---	---

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
14D*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Buse.					
15*:					
Emrick	---	Tatarian honeysuckle, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Heimdal	---	Eastern redcedar, lilac, American plum, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
15B*:					
Heimdal	---	Eastern redcedar, lilac, American plum, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Emrick	---	Tatarian honeysuckle, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
15C*:					
Heimdal	---	Eastern redcedar, lilac, American plum, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Esmond	Siberian peashrub, Tatarian honeysuckle.	Green ash, ponderosa pine, Russian-olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm	---	---

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
15D*: Esmond.					
Heimdal	---	Eastern redcedar, lilac, American plum, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
16B*, 16C*, 16D*: Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Sioux.					
17B*: Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
18 Bearden	---	Redosier dogwood, ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum, Peking cotoneaster.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
19 Colvin	Silver buffaloberry, Siberian peashrub.	---	Russian-olive, green ash, Siberian elm.	---	---
20 Bearden	Siberian peashrub, silver buffaloberry.	---	Green ash, Russian-olive, Siberian elm.	---	---

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
22*:					
Bearden	---	Redosier dogwood, ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum, Peking cotoneaster.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Perella	---	Eastern redcedar, American plum, ponderosa pine, Siberian peashrub, redosier dogwood, common chokecherry, Tatarian honeysuckle, Peking cotoneaster.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
23F*:					
Buse.					
Barnes.					
24, 25 Cashel	---	Redosier dogwood, ponderosa pine, Peking cotoneaster, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
26 Colvin	---	American plum, Siberian peashrub, common chokecherry, lilac, eastern redcedar, redosier dogwood, Tatarian honeysuckle.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow	Eastern cottonwood.
27 Divide	---	Redosier dogwood, ponderosa pine, Tatarian honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
29 Fargo	Silver buffaloberry, Siberian peashrub.	---	Russian-olive, green ash, Siberian elm.	---	---

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
31B Embden	---	Peking cotoneaster, ponderosa pine, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
32 Fargo	---	Redosier dogwood, American plum, Siberian peashrub, Tatarian honeysuckle, common chokecherry, eastern redcedar, lilac.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
35 Fairdale	---	Ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum, Peking cotoneaster, redosier dogwood.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
36 Fargo	---	Redosier dogwood, American plum, Siberian peashrub, Tatarian honeysuckle, common chokecherry, eastern redcedar, lilac.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
37 Fargo	American plum	Siberian peashrub, redosier dogwood, Tatarian honeysuckle, lilac, common chokecherry, eastern redcedar.	Black Hills spruce, Siberian peashrub, green ash.	Golden willow	Eastern cottonwood.
38 Fargo	---	Redosier dogwood, American plum, Siberian peashrub, Tatarian honeysuckle, common chokecherry, eastern redcedar, lilac.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
39 Galchutt	---	American plum, ponderosa pine, redosier dogwood, common chokecherry, eastern redcedar, Peking cotoneaster, Tatarian honeysuckle, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
40*:					
Fargo	---	Redosier dogwood, American plum, Siberian peashrub, Tatarian honeysuckle, common chokecherry, eastern redcedar, lilac.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
Hegne	American plum	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
41*:					
Hegne	American plum	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
Fargo	---	Redosier dogwood, American plum, Siberian peashrub, Tatarian honeysuckle, common chokecherry, eastern redcedar, lilac.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
43 Gardena	---	Tatarian honeysuckle, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
46*:					
Gardena	---	Tatarian honeysuckle, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Glyndon	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Tatarian honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
47 Fargo	---	Redosier dogwood, American plum, Siberian peashrub, Tatarian honeysuckle, common chokecherry, eastern redcedar, lilac.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
48 Glyndon	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Tatarian honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
49 Glyndon	Siberian peashrub, silver buffaloberry.	---	Siberian elm, green ash, Russian-olive.	---	---
50*:					
Hamerly	---	Redosier dogwood, ponderosa pine, Tatarian honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
50*: Tonka	---	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub, American plum.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
50B: Hamerly	---	Redosier dogwood, ponderosa pine, Tatarian honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
51: Hamerly	Silver buffaloberry, Siberian peashrub.	---	Russian-olive, green ash, Siberian elm.	---	---
54: Lamoure	American plum	Eastern redcedar, redosier dogwood, Siberian peashrub, Tatarian honeysuckle, common chokecherry, lilac.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow	Eastern cottonwood.
55: LaDelle	---	Ponderosa pine, Tatarian honeysuckle, eastern redcedar, common chokecherry, Siberian peashrub, American plum, Peking cotoneaster.	Black Hills spruce, green ash, Siberian crabapple.	Golden willow	Eastern cottonwood.
57: Fairdale	---	Ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum, Peking cotoneaster, redosier dogwood.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
58B: Maddock	---	Lilac, silver buffaloberry, common chokecherry, Siberian peashrub, eastern redcedar, Tatarian honeysuckle, American plum, Siberian crabapple.	Green ash, ponderosa pine, Russian-olive, bur oak.	---	---
59, 59B: Overly	---	Tatarian honeysuckle, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
61*:					
Perella	---	Eastern redcedar, American plum, ponderosa pine, Siberian peashrub, redosier dogwood, common chokecherry, Tatarian honeysuckle, Peking cotoneaster.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
Bearden	---	Redosier dogwood, ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum, Peking cotoneaster.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
62*:					
Overly	---	Tatarian honeysuckle, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
62*:					
Bearden	---	Redosier dogwood, ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum, Peking cotoneaster.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
63B*:					
Renshaw	Silver buffaloberry, Tatarian honeysuckle, Siberian peashrub, lilac.	Green ash, eastern redcedar, Siberian crabapple, Rocky Mountain juniper, common chokecherry.	Ponderosa pine, Russian-olive.	---	---
Sioux.					
63C.					
Sioux					
64*.					
Pits					
65*:					
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
66*:					
Wyard	---	Tatarian honeysuckle, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
66*: Hamerly	---	Redosier dogwood, ponderosa pine, Tatarian honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
67 Galchutt	---	American plum, ponderosa pine, redosier dogwood, common chokecherry, eastern redcedar, Peking cotoneaster, Tatarian honeysuckle, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
71 Vallers	American plum	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
72 Wahpeton	---	Peking cotoneaster, ponderosa pine, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
73. Rauville					
76, 76B Wyndmere	Lilac	Siberian peashrub, common chokecherry, Tatarian honeysuckle, eastern redcedar.	Russian-olive, blue spruce, white spruce, bur oak.	Golden willow, Siberian elm.	Eastern cottonwood.
77 Vallers	Siberian peashrub, silver buffaloberry.	---	Siberian elm, green ash, Russian-olive.	---	---

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
78B*:					
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
Buse	Siberian peashrub, Tatarian honeysuckle, lilac.	Ponderosa pine, Russian-olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm, green ash.	---	---
80*:					
Wyndmere	Lilac	Siberian peashrub, common chokecherry, Tatarian honeysuckle, eastern redcedar.	Russian-olive, blue spruce, white spruce, bur oak.	Golden willow, Siberian elm.	Eastern cottonwood.
Tiffany	---	Lilac, redosier dogwood, eastern redcedar, American plum, common chokecherry, Siberian peashrub, Tatarian honeysuckle.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
82*:					
Glyndon	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Tatarian honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
Tiffany	---	Lilac, redosier dogwood, eastern redcedar, American plum, common chokecherry, Siberian peashrub, Tatarian honeysuckle.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
83*:					
Galchutt	---	American plum, ponderosa pine, redosier dogwood, common chokecherry, eastern redcedar, Peking cotoneaster, Tatarian honeysuckle, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Fargo	---	Redosier dogwood, American plum, Siberian peashrub, Tatarian honeysuckle, common chokecherry, eastern redcedar, lilac.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
84*:					
Bearden	---	Redosier dogwood, ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum, Peking cotoneaster.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Lindaas	---	Lilac, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
85 Fairdale Variant	---	Ponderosa pine, common chokecherry, eastern redcedar, Siberian peashrub, Tatarian honeysuckle, American plum, redosier dogwood, Peking cotoneaster.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
1*:				
Fargo	Severe: wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
Enloe	Severe: ponding, too clayey.	Severe: ponding, too clayey.	Severe: too clayey, ponding.	Severe: ponding, too clayey.
2 Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
3 Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
4 Perella	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
5 Dovray	Severe: ponding, too clayey, percs slowly.	Severe: ponding, too clayey, percs slowly.	Severe: ponding, too clayey, percs slowly.	Severe: too clayey, ponding.
6 Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
9C*:				
Nutley	Moderate: percs slowly, too clayey.	Moderate: too clayey, percs slowly.	Moderate: percs slowly, slope.	Moderate: too clayey.
Fargo	Severe: flooding, wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
10*:				
Fargo	Severe: flooding, wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
Ryan	Severe: flooding, wetness, percs slowly.	Severe: wetness, too clayey, excess sodium.	Severe: too clayey, wetness, percs slowly.	Severe: wetness, too clayey.
11 Nahon	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
12*:				
Hegne	Severe: wetness, percs slowly.	Severe: too clayey, percs slowly.	Severe: too clayey, wetness, percs slowly.	Severe: too clayey.
Enloe	Severe: ponding, too clayey.	Severe: ponding, too clayey.	Severe: too clayey, ponding.	Severe: ponding, too clayey.
14B*:				
Barnes	Slight	Slight	Moderate: slope.	Slight.

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
14B*:				
Buse	Slight	Slight	Moderate: slope, small stones.	Slight.
14C*:				
Barnes	Slight	Slight	Severe: slope.	Slight.
Buse	Slight	Slight	Severe: slope.	Slight.
14D*:				
Barnes	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Buse	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
15*:				
Emrick	Slight	Slight	Moderate: slope.	Slight.
Heimdal	Slight	Slight	Moderate: slope.	Slight.
15B*:				
Heimdal	Slight	Slight	Moderate: slope.	Slight.
Emrick	Slight	Slight	Moderate: slope.	Slight.
15C*:				
Heimdal	Slight	Slight	Severe: slope.	Slight.
Esmond	Slight	Slight	Severe: slope.	Slight.
15D*:				
Esmond	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Heimdal	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
16B*:				
Barnes	Slight	Slight	Moderate: slope.	Slight.
Sioux	Slight	Slight	Moderate: slope, small stones.	Slight.
16C*:				
Barnes	Slight	Slight	Severe: slope.	Slight.
Sioux	Slight	Slight	Severe: slope.	Slight.
16D*:				
Barnes	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Sioux	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
17B*:				
Barnes	Slight	Slight	Moderate: slope.	Slight.
Svea	Slight	Slight	Moderate: slope.	Slight.
18 Bearden	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
19 Colvin	Severe: flooding, wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
20 Bearden	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Slight.
22*:				
Bearden	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
Perella	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
23F*:				
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
24, 25 Cashel	Severe: flooding, wetness.	Severe: too clayey.	Severe: too clayey, wetness.	Severe: too clayey.
26 Colvin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
27 Divide	Slight	Slight	Slight	Slight.
29 Fargo	Severe: flooding, wetness, too clayey.	Severe: wetness, too clayey, excess salt.	Severe: wetness.	Severe: wetness, too clayey.
31B Embden	Slight	Slight	Moderate: slope.	Slight.
32 Fargo	Severe: flooding, wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
35 Fairdale	Severe: flooding.	Slight	Moderate: slope, flooding.	Slight.
36 Fargo	Severe: flooding, wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
37 Fargo	Severe: ponding, too clayey.	Severe: ponding, too clayey.	Severe: too clayey, ponding.	Severe: ponding, too clayey.
38 Fargo	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
39 Galchutt	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.
40*:				
Fargo	Severe: flooding, wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
Hegne	Severe: flooding, wetness, percs slowly.	Severe: too clayey, percs slowly.	Severe: too clayey, wetness, percs slowly.	Severe: too clayey.
41*:				
Hegne	Severe: flooding, wetness, percs slowly.	Severe: too clayey, percs slowly.	Severe: too clayey, wetness, percs slowly.	Severe: too clayey.
Fargo	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
43 Gardena	Slight	Slight	Slight	Slight.
46*:				
Gardena	Slight	Slight	Slight	Slight.
Glyndon	Slight	Slight	Slight	Slight.
47 Fargo	Severe: flooding, wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
48 Glyndon	Slight	Slight	Slight	Slight.
49 Glyndon	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Slight.
50*:				
Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
50B Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight.
51 Hamerly	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Slight.

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
54 Lamoure	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
55 LaDelle	Severe: flooding.	Slight	Moderate: flooding.	Slight.
57 Fairdale	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.
58B Maddock	Slight	Slight	Moderate: slope.	Slight.
59 Overly	Slight	Slight	Slight	Slight.
59B Overly	Slight	Slight	Moderate: slope.	Slight.
61*:				
Perella	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
Bearden	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
62*:				
Overly	Slight	Slight	Slight	Slight.
Bearden	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
63B*:				
Renshaw	Slight	Slight	Moderate: slope.	Slight.
Sioux	Slight	Slight	Moderate: slope, small stones.	Slight.
63C Sioux	Moderate: small stones.	Slight	Severe: slope, small stones.	Slight.
64*. Pits				
65*:				
Svea	Slight	Slight	Slight	Slight.
Barnes	Slight	Slight	Slight	Slight.
66*:				
Wyard	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight.
67 Galchutt	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
71 Vallers	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
72 Wahpeton	Severe: flooding.	Moderate: too clayey.	Moderate: too clayey, flooding.	Moderate: too clayey.
73 Rauville	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.
76 Wyndmere	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight.
76B Wyndmere	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight.
77 Vallers	Severe: wetness, excess humus.	Severe: wetness, excess humus, excess salt.	Severe: excess humus, wetness, excess salt.	Severe: wetness, excess humus.
78B*:				
Svea	Slight	Slight	Moderate: slope.	Slight.
Buse	Slight	Slight	Moderate: slope, small stones.	Slight.
80*:				
Wyndmere	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight.
Tiffany	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
82*:				
Glyndon	Slight	Slight	Slight	Slight.
Tiffany	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
83*:				
Galchutt	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.
Fargo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
84*:				
Bearden	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
Lindaas	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
85 Fairdale Variant	Severe: flooding.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba- ceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
1*:									
Fargo	Good	Good	Fair	Poor	Poor	Good	Fair	Fair	Poor.
Enloe	Good	Good	Good	Fair	Poor	Good	Good	Fair	Fair.
2 Tonka	Good	Good	Fair	Poor	Good	Good	Good	Good	Poor.
3 Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
4 Perella	Good	Good	Good	Fair	Good	Good	Good	Good	Fair.
5 Dovray	Poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
6 Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
9C*:									
Nutley	Fair	Fair	Poor	Poor	Poor	Very poor	Fair	Very poor	Poor.
Fargo	Good	Good	Fair	Poor	Poor	Fair	Fair	Poor	Poor.
10*:									
Fargo	Good	Good	Fair	Poor	Poor	Good	Fair	Fair	Poor.
Ryan	Poor	Poor	Poor	Very poor	Poor	Good	Poor	Fair	Very poor.
11 Nahon	Poor	Poor	Poor	Very poor	Very poor	Very poor	Poor	Poor	Poor.
12*:									
Hegne	Fair	Fair	Fair	Fair	Poor	Good	Fair	Fair	Fair.
Enloe	Good	Good	Good	Fair	Poor	Good	Good	Fair	Fair.
14B*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
14C*:									
Barnes	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
14D*:									
Barnes	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
Buse	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
15*:									
Emrick	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Heimdal	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
15B*:									
Heimdal	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.

See footnote at end of table.

TABLE 8.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife	Rangeland wildlife
15B*:									
Emrick	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
15C*:									
Heimdal	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Esmond	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
15D*:									
Esmond	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Heimdal	Poor	Fair	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
16B*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
16C*:									
Barnes	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
16D*:									
Barnes	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
17B*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Svea	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
18 Bearden	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
19 Colvin	Fair	Fair	Poor	Fair	Good	Good	Fair	Good	Poor.
20 Bearden	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Poor.
22*:									
Bearden	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Perella	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
23F*:									
Buse	Poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Barnes	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
24, 25 Cashel	Good	Good	Fair	Good	Poor	Fair	Good	Poor	Fair.
26 Colvin	Fair	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
27 Divide	Fair	Fair	Good	Fair	Fair	Very poor	Fair	Poor	Fair.
29 Fargo	Fair	Fair	Fair	Very poor	Poor	Good	Fair	Fair	Poor.
31B Embden	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.

See footnote at end of table.

TABLE 8.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
32------------------ Fargo	Good	Good	Fair	Poor	Poor	Fair	Fair	Poor	Poor.
35------------------ Fairdale	Good	Good	Fair	Good	Poor	Poor	Good	Poor	Fair.
36------------------ Fargo	Good	Good	Fair	Poor	Poor	Good	Fair	Fair	Poor.
37------------------ Fargo	Very poor	Poor	Fair	Poor	Poor	Good	Poor	Fair	Poor.
38------------------ Fargo	Good	Good	Fair	Poor	Good	Good	Fair	Good	Poor.
39------------------ Galchutt	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
40*:									
Fargo-------------	Good	Good	Fair	Poor	Poor	Good	Fair	Fair	Poor.
Hegne-------------	Fair	Fair	Fair	Fair	Poor	Good	Fair	Fair	Fair.
41*:									
Hegne-------------	Fair	Fair	Fair	Fair	Poor	Good	Fair	Fair	Fair.
Fargo-------------	Good	Good	Fair	Poor	Good	Good	Fair	Good	Poor.
43------------------ Gardena	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
46*:									
Gardena-----------	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Glyndon-----------	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
47------------------ Fargo	Good	Good	Fair	Poor	Poor	Good	Fair	Fair	Poor.
48------------------ Glyndon	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
49------------------ Glyndon	Fair	Fair	Good	Fair	Poor	Poor	Fair	Poor	Fair.
50*:									
Hamerly-----------	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Tonka-------------	Good	Good	Fair	Poor	Good	Good	Good	Good	Poor.
50B----------------- Hamerly	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
51------------------ Hamerly	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Fair.
54------------------ Lamoure	Good	Good	Fair	Fair	Fair	Fair	Good	Fair	Fair.
55------------------ LaDelle	Good	Good	Fair	Good	Very poor	Very poor	Good	Very poor	Fair.
57------------------ Fairdale	Poor	Poor	Fair	Good	Poor	Poor	Poor	Poor	Good.

See footnote at end of table.

TABLE 8.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba-ceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
58B----------------- Maddock	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
59----------------- Overly	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
59B----------------- Overly	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
61*:									
Perella-----------	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Bearden-----------	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
62*:									
Overly------------	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Bearden-----------	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
63B*:									
Renshaw-----------	Poor	Fair	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
Sioux-------------	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
63C----------------- Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
64*. Pits									
65*:									
Svea--------------	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Barnes------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
66*:									
Wyard-------------	Good	Good	Good	Good	Fair	Fair	Good	Fair	Good.
Hamerly-----------	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
67----------------- Galchutt	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
71----------------- Vallers	Fair	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
72----------------- Wahpeton	Good	Good	Fair	Poor	Poor	Poor	Fair	Poor	Poor.
73----------------- Rauville	Very poor	Poor	Fair	Fair	Fair	Fair	Very poor	Fair	Fair.
76, 76B------------ Wyndmere	Fair	Good	Good	Fair	Fair	Poor	Good	Poor	Fair.
77----------------- Vallers	Fair	Fair	Very poor	Fair	Good	Good	Fair	Good	Poor.
78B*:									
Svea--------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse--------------	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
80*:									
Wyndmere----------	Fair	Good	Good	Fair	Fair	Poor	Good	Poor	Fair.

See footnote at end of table.

TABLE 8.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba- ceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
80*:									
Tiffany-----------	Good	Good	Good	Fair	Good	Fair	Good	Fair	Fair.
82*:									
Glyndon-----------	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Tiffany-----------	Good	Good	Good	Fair	Good	Fair	Good	Fair	Fair.
83*:									
Galchutt----------	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Fargo-------------	Good	Good	Fair	Poor	Good	Good	Fair	Good	Poor.
84*:									
Bearden-----------	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Lindaas-----------	Good	Good	Fair	Poor	Good	Good	Good	Good	Poor.
85----------------- Fairdale Variant	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition; it does not eliminate the need for onsite investigation]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
1*:					
Fargo	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness.
Enloe	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
2 Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
3 Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, frost action.
4 Perella	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.
5 Dovray	Severe: ponding.	Severe: shrink-swell, ponding, low strength.	Severe: shrink-swell, ponding.	Severe: shrink-swell, ponding, low strength.	Severe: ponding, low strength, shrink-swell.
6 Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, frost action.
9C*:					
Nutley	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Fargo	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness.
10*:					
Fargo	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.
Ryan	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.
11 Nahon	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
12*:					
Hegne	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, shrink-swell.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
12*:					
Enloe	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
14B*, 14C*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
Buse	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
14D*:					
Barnes	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.
Buse	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.
15*:					
Emrick	Slight	Slight	Slight	Slight	Moderate: frost action.
Heimdal	Slight	Slight	Slight	Slight	Moderate: frost action.
15B*:					
Heimdal	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
Emrick	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
15C*:					
Heimdal	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
Esmond	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
15D*:					
Esmond	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.
Heimdal	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.
16B*, 16C*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
Sioux	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
16D*:					
Barnes	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.
Sioux	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
17B*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, frost action.
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
18 Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.
19 Colvin	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.
20 Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.
22*:					
Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.
Perella	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.
23F*:					
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
24, 25 Cashel	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding.
26 Colvin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness, frost action.
27 Divide	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: low strength, frost action.
29 Fargo	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.
31B Embden	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
32 Fargo	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness.
35 Fairdale	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
36 Fargo	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.
37 Fargo	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
38 Fargo	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness.
39 Galchutt	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.
40*:					
Fargo	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.
Hegne	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, shrink-swell.
41*:					
Hegne	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, shrink-swell.
Fargo	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.
43 Gardena	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.
46*:					
Gardena	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.
Glyndon	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Severe: frost action.
47 Fargo	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.
48, 49 Glyndon	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Severe: frost action.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
50*:					
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
50B Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell, slope.	Severe: frost action.
51 Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
54 Lamoure	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.
55 LaDelle	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.
57 Fairdale	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
58B Maddock	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
59 Overly	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.
59B Overly	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.
61*:					
Perella	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.
Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.
62*:					
Overly	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.
Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.
63B*:					
Renshaw	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
Sioux	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
63C----------------- Sioux	Severe: cutbanks cave.	Slight-----------	Slight-----------	Moderate: slope.	Slight.
64*. Pits					
65*: Svea-------------	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
Barnes-----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, frost action.
66*: Wyard------------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
Hamerly----------	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
67---------------- Galchutt	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.
71---------------- Vallers	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
72---------------- Wahpeton	Moderate: too clayey, flooding.	Severe: flooding, shrink-swell.	Severe: flooding, shrink-swell.	Severe: flooding, shrink-swell.	Severe: low strength, flooding, frost action.
73---------------- Rauville	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.
76---------------- Wyndmere	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.
76B--------------- Wyndmere	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness, slope.	Severe: frost action.
77---------------- Vallers	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
78B*: Svea-------------	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope.	Severe: low strength.
Buse-------------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
80*: Wyndmere---------	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
80*:					
Tiffany	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.
82*:					
Glyndon	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Severe: frost action.
Tiffany	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.
83*:					
Galchutt	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.
Fargo	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness.
84*:					
Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.
Lindaas	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.
85 Fairdale Variant	Severe: wetness.	Severe: flooding.	Severe: flooding, wetness, shrink-swell.	Severe: flooding.	Severe: frost action.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition; it does not eliminate the need for onsite investigation]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1*:					
Fargo	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Enloe	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
2 Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
3 Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
4 Perella	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
5 Dovray	Severe: percs slowly, ponding.	Slight	Severe: too clayey, ponding.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
6 Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
9C*:					
Nutley	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
Fargo	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
10*:					
Fargo	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Ryan	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
11 Nahon	Severe: percs slowly.	Slight	Severe: wetness, too clayey, excess sodium.	Moderate: wetness.	Poor: too clayey, hard to pack, excess sodium.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
12*:					
Hegne	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Enloe	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
14B*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Buse	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
14C*:					
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Buse	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
14D*:					
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Buse	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
15*:					
Emrick	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Heimdal	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
15B*:					
Heimdal	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Emrick	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
15C*:					
Heimdal	Slight	Severe: slope.	Slight	Slight	Good.
Esmond	Slight	Severe: slope.	Slight	Slight	Good.
15D*:					
Esmond	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Heimdal	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
16B*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Sioux	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
16C*:					
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Sioux	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
16D*:					
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Sioux	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
17B*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
18 Bearden	Severe: wetness, percs slowly.	Slight	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
19 Colvin	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
20 Bearden	Severe: wetness, percs slowly.	Slight	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
22*:					
Bearden	Severe: wetness, percs slowly.	Slight	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Perella	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
23F*:					
Buse	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
23F*:					
Barnes	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
24, 25 Cashel	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: too clayey, hard to pack.
26 Colvin	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
27 Divide	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
29 Fargo	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
31B Embden	Moderate: wetness.	Severe: seepage.	Severe: seepage, wetness.	Severe: seepage.	Fair: too sandy, thin layer.
32 Fargo	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
35 Fairdale	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
36 Fargo	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
37 Fargo	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
38 Fargo	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
39 Galchutt	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
40*:					
Fargo	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Hegne	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
41*:					
Hegne	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Fargo	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
43 Gardena	Moderate: wetness.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Good.
46*:					
Gardena	Moderate: wetness.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Good.
Glyndon	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Fair: wetness.
47 Fargo	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
48 Glyndon	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Fair: wetness.
49 Glyndon	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Fair: too sandy, wetness.
50*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
50B, 51 Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
54 Lamoure	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
55 LaDelle	Severe: flooding.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Poor: hard to pack.
57 Fairdale	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
58B Maddock	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
59: Overly	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Poor: thin layer.
59B: Overly	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Poor: thin layer.
61*:					
Perella	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Bearden	Severe: wetness, percs slowly.	Slight	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
62*:					
Overly	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Poor: thin layer.
Bearden	Severe: wetness, percs slowly.	Slight	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
63B*:					
Renshaw	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Sioux	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
63C: Sioux	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
64*. Pits					
65*:					
Svea	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Barnes	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
66*:					
Wyard	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
67: Galchutt	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
71: Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
72------------------ Wahpeton	Severe: flooding, percs slowly.	Severe: flooding.	Severe: flooding, too clayey.	Severe: flooding.	Poor: too clayey, hard to pack.
73------------------ Rauville	Severe: flooding, wetness, percs slowly.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
76, 76B------------- Wyndmere	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
77------------------ Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
78B*:					
Svea----------------	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Buse----------------	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
80*:					
Wyndmere------------	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
Tiffany-------------	Severe: ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: ponding.
82*:					
Glyndon-------------	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Fair: wetness.
Tiffany-------------	Severe: ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: ponding.
83*:					
Galchutt------------	Severe: wetness, percs slowly.	Slight-----------	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Fargo---------------	Severe: wetness, percs slowly.	Slight-----------	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
84*:					
Bearden-------------	Severe: wetness, percs slowly.	Slight-----------	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Lindaas-------------	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
85------------------ Fairdale Variant	Severe: wetness, percs slowly.	Severe: wetness.	Severe: too clayey.	Moderate: flooding, wetness.	Poor: too clayey. hard to pack.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition; it does not eliminate the need for onsite investigation]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1*:				
Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Enloe	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
2 Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
3 Parnell	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
4 Perella	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
5 Dovray	Poor: wetness, shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
6 Parnell	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
9C*:				
Nutley	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
10*:				
Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Ryan	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness, excess sodium.
11 Nahon	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
12*:				
Hegne	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
12*:				
Enloe	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
14B*, 14C*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
14D*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
15*:				
Emrick	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Heimdal	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
15B*:				
Heimdal	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Emrick	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
15C*:				
Heimdal	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Esmond	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
15D*:				
Esmond	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Heimdal	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
16B*, 16C*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
16D*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
16D*:				
Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
17B*:				
BarneO!	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
18 Bearden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
19 Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
20 Bearden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.
22*:				
Bearden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Perella	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
23F*:				
Buse	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Barnes	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
24, 25 Cashel	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
26 Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
27 Divide	Fair: wetness.	Probable	Probable	Poor: small stones, area reclaim.
29 Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salt, wetness.
31B Embden	Good	Probable	Probable	Fair: area reclaim.
32 Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
35 Fairdale	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
36, 37 Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
38 Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
39 Galchutt	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
40*:				
Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Hegne	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
41*:				
Hegne	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
43 Gardena	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
46*:				
Gardena	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Glyndon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
47 Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
48 Glyndon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
49 Glyndon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.
50*:				
Hamerly	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
50B-------------------- Hamerly	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
51--------------------- Hamerly	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.
54--------------------- Lamoure	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
55--------------------- LaDelle	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
57--------------------- Fairdale	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
58B-------------------- Maddock	Good-----------------	Probable-------------	Improbable: too sandy.	Poor: thin layer.
59, 59B---------------- Overly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
61*:				
Perella---------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Bearden---------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
62*:				
Overly----------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Bearden---------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
63B*:				
Renshaw---------------	Good-----------------	Probable-------------	Probable-------------	Poor: small stones, area reclaim.
Sioux-----------------	Good-----------------	Probable-------------	Probable-------------	Poor: small stones, area reclaim.
63C-------------------- Sioux	Good-----------------	Probable-------------	Probable-------------	Poor: small stones, area reclaim.
64*. Pits				
65*:				
Svea------------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Barnes----------------	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
66*:				
Wyard	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Hamerly	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
67 Galchutt	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
71 Vallers	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
72 Wahpeton	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
73 Rauville	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
76, 76B Wyndmere	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
77 Vallers	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
78B*:				
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
80*:				
Wyndmere	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
Tiffany	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
82*:				
Glyndon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
Tiffany	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
83*:				
Galchutt	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, thin layer.
Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
84*:				
Bearden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
84*:				
Lindaas--------------	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
85-------------------- Fairdale Variant	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition; it does not eliminate the need for onsite investigation]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
1*:						
Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
Enloe	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, slow intake, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
2 Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
3 Parnell	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
4 Perella	Slight	Severe: piping, ponding.	Ponding, frost action.	Ponding	Ponding	Wetness.
5 Dovray	Slight	Severe: hard to pack, ponding, excess humus.	Percs slowly, ponding.	Ponding, slow intake, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
6 Parnell	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
9C*:						
Nutley	Moderate: slope.	Moderate: hard to pack.	Deep to water	Droughty, slow intake, percs slowly.	Percs slowly	Droughty, percs slowly.
Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
10*:						
Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
Ryan	Slight	Severe: hard to pack, wetness, excess sodium.	Percs slowly, flooding, excess salt.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, excess sodium, percs slowly.
11 Nahon	Slight	Severe: hard to pack, excess sodium.	Deep to water	Percs slowly, excess sodium, excess salt.	Erodes easily, percs slowly.	Excess sodium, erodes easily, percs slowly.
12*:						
Hegne	Slight	Severe: hard to pack, wetness.	Percs slowly	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
Enloe	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, slow intake, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
14B*, 14C*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
14B*, 14C*:						
Buse	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
14D*:						
Barnes	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Buse	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
15*:						
Emrick	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Heimdal	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
15B*:						
Heimdal	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Emrick	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
15C*:						
Heimdal	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Esmond	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
15D*:						
Esmond	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Heimdal	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
16B*, 16C*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Sioux	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy	Droughty.
16D*:						
Barnes	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, slope.	Slope, too sandy.	Droughty, slope.
17B*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Svea	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
18 Bearden	Moderate: seepage.	Moderate: piping, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
19: Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, flooding, frost action.	Wetness, percs slowly, flooding.	Wetness, percs slowly.	Wetness, excess salt, percs slowly.
20: Bearden	Moderate: seepage.	Severe: piping.	Percs slowly, frost action, excess salt.	Wetness, percs slowly.	Wetness, percs slowly.	Excess salt, percs slowly.
22*:						
Bearden	Moderate: seepage.	Moderate: piping, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.
Perella	Slight	Severe: piping.	Frost action	Wetness	Wetness	Favorable.
23F*:						
Buse	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Barnes	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
24, 25: Cashel	Slight	Severe: wetness.	Percs slowly, flooding.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
26: Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
27: Divide	Severe: seepage.	Severe: seepage.	Cutbanks cave	Wetness	Wetness, too sandy.	Favorable.
29: Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, excess salt, percs slowly.
31B: Embden	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing, slope.	Soil blowing	Favorable.
32: Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
35: Fairdale	Moderate: seepage.	Severe: piping.	Deep to water	Flooding	Favorable	Favorable.
36: Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
37: Fargo	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, slow intake, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
38: Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
39: Galchutt	Moderate: seepage.	Severe: hard to pack.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
40*:						
Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
40*: Hegne	Slight	Severe: hard to pack, wetness.	Percs slowly	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
41*: Hegne	Slight	Severe: hard to pack, wetness.	Percs slowly	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
43 Gardena	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
46*: Gardena	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Glyndon	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness	Wetness	Favorable.
47 Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
48 Glyndon	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness	Wetness	Favorable.
49 Glyndon	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave, excess salt.	Wetness, excess salt.	Wetness	Excess salt.
50*: Hamerly	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
50B Hamerly	Moderate: seepage, slope.	Severe: piping.	Frost action, slope.	Wetness, slope.	Erodes easily, wetness.	Erodes easily.
51 Hamerly	Moderate: seepage.	Severe: piping.	Frost action, excess salt.	Wetness, excess salt.	Erodes easily, wetness.	Excess salt, erodes easily.
54 Lamoure	Moderate: seepage.	Severe: hard to pack, wetness.	Flooding, frost action.	Wetness, flooding.	Wetness	Wetness.
55 LaDelle	Moderate: seepage.	Severe: hard to pack.	Deep to water	Flooding	Favorable	Favorable.
57 Fairdale	Moderate: seepage.	Severe: piping.	Deep to water	Flooding	Favorable	Favorable.
58B Maddock	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
59 Overly	Slight	Severe: piping.	Deep to water	Percs slowly	Favorable	Percs slowly.
59B Overly	Moderate: slope.	Severe: piping.	Deep to water	Percs slowly, slope.	Favorable	Percs slowly.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
61*:						
Perella	Slight	Severe: piping.	Frost action	Wetness	Wetness	Favorable.
Bearden	Moderate: seepage.	Moderate: piping, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.
62*:						
Overly	Slight	Severe: piping.	Deep to water	Percs slowly	Favorable	Percs slowly.
Bearden	Moderate: seepage.	Moderate: piping, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.
63B*:						
Renshaw	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy	Droughty.
Sioux	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy	Droughty.
63C Sioux	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy	Droughty.
64*. Pits						
65*:						
Svea	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Barnes	Slight	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
66*:						
Wyard	Moderate: seepage.	Severe: piping, wetness.	Frost action	Wetness	Erodes easily, wetness.	Wetness, erodes easily.
Hamerly	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
67 Galchutt	Moderate: seepage.	Severe: hard to pack.	Percs slowly, frost action.	Wetness, percs slowly, soil blowing.	Wetness, percs slowly, soil blowing.	Wetness, percs slowly.
71 Vallers	Slight	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
72 Wahpeton	Moderate: seepage.	Severe: hard to pack.	Deep to water	Slow intake, flooding.	Favorable	Favorable.
73 Rauville	Moderate: seepage.	Severe: hard to pack, wetness.	Flooding, frost action.	Wetness, flooding.	Wetness	Wetness.
76 Wyndmere	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Favorable.
76B Wyndmere	Severe: seepage.	Severe: piping.	Frost action, slope, cutbanks cave.	Wetness, slope.	Wetness, too sandy.	Favorable.
77 Vallers	Slight	Severe: piping, wetness.	Frost action, excess salt.	Wetness, excess salt.	Wetness	Wetness, excess salt.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
78B*:						
Svea	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Buse	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
80*:						
Wyndmere	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Favorable.
Tiffany	Severe: seepage.	Severe: piping, ponding.	Ponding, frost action, cutbanks cave.	Ponding	Ponding	Wetness.
82*:						
Glyndon	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness	Wetness	Favorable.
Tiffany	Severe: seepage.	Severe: piping, ponding.	Ponding, frost action, cutbanks cave.	Ponding	Ponding	Wetness.
83*:						
Galchutt	Moderate: seepage.	Severe: hard to pack.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
84*:						
Bearden	Moderate: seepage.	Moderate: piping, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.
Lindaas	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding.	Wetness, erodes easily, percs slowly.
85 Fairdale Variant	Moderate: seepage.	Moderate: hard to pack, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Percs slowly.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
1*:											
Fargo-----------	0-10	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	10-22	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	22-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
Enloe-----------	0-15	Silty clay-------	CH	A-7	0	100	100	95-100	90-95	50-75	25-45
	15-42	Silty clay, clay	CH	A-7	0	100	100	95-100	75-95	50-75	25-45
	42-60	Silty clay, clay, clay loam.	CH, CL	A-7	0	100	100	90-100	75-95	40-75	20-45
2--------------- Tonka	0-15	Silt loam, loam	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-40	5-25
	15-40	Silty clay loam, clay loam, clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	40-60	Silty clay loam, clay loam, loam.	CL, CL-ML	A-6, A-7, A-4	0-3	90-100	85-100	75-100	55-90	25-50	5-30
3--------------- Parnell	0-18	Silty clay loam, silt loam.	CL, CH	A-7	0	100	100	95-100	85-95	40-60	15-30
	18-40	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-95	40-80	20-50
	40-60	Clay loam, loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
4--------------- Perella	0-18	Silty clay loam	CL	A-6, A-7	0	100	95-100	95-100	85-95	25-50	10-30
	18-30	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-7, A-6	0	100	95-100	95-100	80-100	25-45	5-25
	30-60	Silt loam, silt, silty clay loam.	ML, CL, CL-ML	A-4, A-6, A-7	0	100	95-100	95-100	80-100	25-50	5-25
5--------------- Dovray	0-25	Silty clay-------	CH, MH, OH	A-7	0	100	100	95-100	85-95	50-75	25-40
	25-57	Clay, silty clay	CH, MH	A-7	0	100	95-100	90-100	85-95	50-80	25-40
	57-60	Clay, silty clay loam, clay loam.	CH, MH, CL, ML	A-7	0	100	95-100	80-100	70-95	40-75	20-40
6--------------- Parnell	0-18	Silty clay loam, silt loam.	CL, CH	A-7	0	100	100	95-100	85-95	40-60	15-30
	18-40	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-95	40-80	20-50
	40-60	Clay loam, loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
9C*:											
Nutley----------	0-8	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-70	25-40
	8-60	Clay, silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	85-100	50-70	25-40
Fargo-----------	0-10	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	10-22	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	22-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
10*:											
Fargo-----------	0-10	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	10-22	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	22-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
Ryan------------	0-4	Silty clay-------	CH	A-7	0	100	100	95-100	90-95	50-75	25-50
	4-60	Silty clay, clay	CH	A-7	0	100	100	90-100	75-95	50-75	25-50
11-------------- Nahon	0-6	Silt loam--------	CL, ML	A-6, A-7	0	100	100	90-100	80-100	35-50	10-25
	6-8	Silty clay loam, silt loam.	CL, ML	A-6, A-7	0	100	100	95-100	90-100	35-50	10-25
	8-18	Silty clay, silty clay loam.	MH, CH, CL, ML	A-7	0	100	100	95-100	90-100	45-65	15-35
	18-60	Stratified silt to clay.	CL, CH, ML, MH	A-7	0	100	100	90-100	75-100	40-70	15-35

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
12*:											
Hegne-----------	0-7	Silty clay-------	CH	A-7	0	100	100	95-100	90-98	50-70	25-40
	7-31	Silty clay, clay	CH	A-7	0	100	100	95-100	95-98	50-70	25-40
	31-60	Clay, silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	50-70	25-45
Enloe-----------	0-15	Silty clay-------	CH	A-7	0	100	100	95-100	90-95	50-75	25-45
	15-42	Silty clay, clay	CH	A-7	0	100	100	95-100	75-95	50-75	25-45
	42-60	Silty clay, clay, clay loam.	CH, CL	A-7	0	100	100	90-100	75-95	40-75	20-45
14B*, 14C*, 14D*:											
Barnes----------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-14	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	14-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Buse------------	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-95	60-85	25-40	5-20
15*:											
Emrick----------	0-16	Loam-------------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	16-23	Loam-------------	ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	23-60	Loam, sandy loam	ML, SM	A-4	0-5	95-100	95-100	60-100	35-90	20-40	NP-10
Heimdal---------	0-6	Loam-------------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	6-15	Loam-------------	ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	15-48	Loam, sandy loam	ML, SM	A-4	0-5	95-100	95-100	60-100	35-90	20-40	NP-10
	48-60	Fine sand, loamy fine sand, loamy sand.	SM, SM-SC, SP-SM	A-2	0-5	95-100	95-100	85-100	10-35	15-30	NP-7
15B*:											
Heimdal---------	0-6	Loam-------------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	6-15	Loam-------------	ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	15-48	Loam, sandy loam	ML, SM	A-4	0-5	95-100	95-100	60-100	35-90	20-40	NP-10
	48-60	Fine sand, loamy fine sand, loamy sand.	SM, SM-SC, SP-SM	A-2	0-5	95-100	95-100	85-100	10-35	15-30	NP-7
Emrick----------	0-16	Loam-------------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	16-23	Loam-------------	ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	23-60	Loam, sandy loam	ML, SM	A-4	0-5	95-100	95-100	60-100	35-90	20-40	NP-10
15C*:											
Heimdal---------	0-6	Loam-------------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	6-15	Loam-------------	ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	15-48	Loam, sandy loam	ML, SM	A-4	0-5	95-100	95-100	60-100	35-90	20-40	NP-10
	48-60	Fine sand, loamy fine sand, loamy sand.	SM, SM-SC, SP-SM	A-2	0-5	95-100	95-100	85-100	10-35	15-30	NP-7
Esmond----------	0-6	Loam-------------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	6-60	Loam, sandy loam, fine sandy loam.	ML, SM	A-4	0-5	95-100	95-100	60-100	35-90	20-40	NP-10
15D*:											
Esmond----------	0-6	Loam-------------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	6-60	Loam, sandy loam, fine sandy loam.	ML, SM	A-4	0-5	95-100	95-100	60-100	35-90	20-40	NP-10
Heimdal---------	0-6	Loam-------------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	6-15	Loam-------------	ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	15-48	Loam, sandy loam	ML, SM	A-4	0-5	95-100	95-100	60-100	35-90	20-40	NP-10
	48-60	Fine sand, loamy fine sand, loamy sand.	SM, SM-SC, SP-SM	A-2	0-5	95-100	95-100	85-100	10-35	15-30	NP-7

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
16B*, 16C*, 16D*:											
Barnes----------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-14	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	14-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Sioux-----------	0-7	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	85-100	70-90	55-75	30-40	5-15
	7-11	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	11-60	Gravelly sand, gravelly loamy sand.	GM, GP, SM, SP	A-1	0	25-75	10-60	5-35	0-25	<25	NP-5
17B*:											
Barnes----------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-14	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	14-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Svea------------	0-18	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	18-28	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	28-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-80	20-50	5-30
18--------------- Bearden	0-9	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	80-95	25-55	10-30
	9-24	Silt loam, silty clay loam.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	25-55	10-30
	24-60	Silt loam, silty clay loam, loam.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	25-55	10-30
19--------------- Colvin	0-8	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	30-50	15-30
	8-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	20-50	10-30
20--------------- Bearden	0-9	Silty clay loam	ML, CL, CH	A-6, A-7, A-4	0	100	100	95-100	80-95	25-55	7-30
	9-24	Silt loam, silty clay loam.	ML, CL, CH	A-6, A-7, A-4	0	100	100	95-100	80-95	25-55	7-30
	24-60	Silt loam, silty clay loam, loam.	ML, CL, CH	A-6, A-7, A-4	0	100	100	95-100	80-95	25-55	7-30
22*:											
Bearden---------	0-9	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	80-95	25-55	10-30
	9-24	Silt loam, silty clay loam.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	25-55	10-30
	24-60	Silt loam, silty clay loam, loam.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	25-55	10-30
Perella---------	0-16	Silty clay loam	CL	A-6, A-7	0	100	95-100	95-100	85-95	25-50	10-30
	16-26	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-7, A-6	0	100	95-100	95-100	80-100	25-45	5-25
	26-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-7, A-6	0	100	95-100	95-100	80-100	25-45	5-25
23F*:											
Buse------------	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-95	60-85	25-40	5-20
Barnes----------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-14	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	14-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
24, 25----------- Cashel	0-7	Silty clay-------	CH, CL	A-7	0	100	100	95-100	85-100	45-70	20-40
	7-60	Silty clay, clay, silty clay loam.	CH, CL, MH	A-7	0	95-100	95-100	95-100	85-100	45-70	20-40

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag-ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
26---------------- Colvin	0-8	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	35-50	15-30
	8-36	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	36-60	Loam, silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25
27---------------- Divide	0-14	Loam-------------	CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-85	25-40	5-20
	14-30	Loam, clay loam, gravelly loam.	CL, CL-ML	A-4, A-6	0-3	95-100	80-100	60-90	55-80	20-40	5-20
	30-60	Stratified sand to gravelly sand.	GM, SM, GP-GM, SP-SM	A-1	0-5	25-75	15-65	10-40	5-25	---	NP
29---------------- Fargo	0-10	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	10-22	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	22-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
31B--------------- Embden	0-11	Fine sandy loam	SM, ML, SC	A-2, A-4	0	100	100	60-95	30-65	<35	NP-10
	11-24	Fine sandy loam, sandy loam.	SM	A-2, A-4	0	100	100	60-85	30-50	---	NP
	24-40	Fine sandy loam, very fine sandy loam, loamy fine sand.	SM	A-2, A-4	0	100	100	50-80	15-50	---	NP
	40-60	Gravelly loamy sand, gravelly loam, gravelly sandy loam.	GM, SM, GP-GM, SP-SM	A-1	0-5	25-75	15-65	10-40	5-25	---	NP
32---------------- Fargo	0-10	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	10-22	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	22-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
35---------------- Fairdale	0-6	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	85-100	60-90	20-40	3-15
	6-60	Stratified very fine sandy loam to silty clay loam.	ML, CL, CL-ML	A-4, A-6	0	100	100	85-100	55-90	20-40	NP-20
36, 37------------ Fargo	0-10	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	10-22	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	22-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
38---------------- Fargo	0-10	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	30-50	11-25
	10-22	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	22-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
39---------------- Galchutt	0-17	Silt loam, loam	ML, CL, CL-ML	A-4, A-6	0	100	100	85-100	60-90	20-40	NP-20
	17-25	Silt loam, loam, very fine sandy loam.	ML, CL, CL-ML	A-4, A-6	0	100	100	95-100	60-95	20-40	NP-20
	25-60	Silty clay, clay	CH	A-7	0	95-100	90-100	85-100	80-100	50-95	25-60
40*:											
Fargo------------	0-10	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	10-22	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	22-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
Hegne------------	0-7	Silty clay-------	CH	A-7	0	100	100	95-100	90-98	50-70	25-40
	7-31	Silty clay, clay	CH	A-7	0	100	100	95-100	95-98	50-70	25-40
	31-60	Clay, silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	50-70	25-45
41*:											
Hegne------------	0-7	Silty clay loam	CL	A-7	0	100	95-100	90-100	85-95	40-50	20-30
	7-31	Silty clay, clay	CH	A-7	0	100	100	95-100	95-98	50-70	25-40
	31-60	Clay, silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	50-70	25-45

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification Unified	Classification AASHTO	Frag- ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
41*:											
Fargo-----------	0-10	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	30-50	11-25
	10-22	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	22-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
43--------------- Gardena	0-11	Silt loam--------	ML	A-4	0	100	100	75-95	60-90	25-40	NP-10
	11-60	Silt loam, very fine sandy loam, loam.	ML	A-4	0	100	100	75-95	55-90	20-40	NP-10
46*:											
Gardena---------	0-11	Silt loam--------	ML	A-4	0	100	100	75-95	60-90	25-40	NP-10
	11-60	Silt loam, very fine sandy loam, loam.	ML	A-4	0	100	100	75-95	55-90	20-40	NP-10
Glyndon---------	0-12	Silt loam--------	OL, ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	12-28	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
	28-60	Silt loam, very fine sand, very fine sandy loam.	ML, SM, SC, CL	A-4	0	100	100	85-100	35-75	10-30	NP-10
47--------------- Fargo	0-10	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	10-22	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	22-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
48--------------- Glyndon	0-12	Silt loam--------	OL, ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	12-28	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
	28-60	Silt loam, very fine sand, very fine sandy loam.	ML, SM, SC, CL	A-4	0	100	100	85-100	35-75	10-30	NP-10
49--------------- Glyndon	0-12	Silt loam--------	OL, ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	12-28	Silt loam, very fine sandy loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
	28-60	Very fine sand, silt loam, very fine sandy loam.	ML, CL-ML, CL, SM	A-4	0	100	100	85-100	45-90	10-30	NP-10
50*:											
Hamerly---------	0-10	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-25
	10-24	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	24-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
Tonka-----------	0-15	Loam-------------	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-40	5-25
	15-40	Silty clay loam, clay loam, clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	40-60	Silty clay loam, clay loam, loam.	CL, CL-ML	A-6, A-7, A-4	0-3	90-100	85-100	75-100	55-90	25-50	5-30
50B-------------- Hamerly	0-10	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-25
	10-24	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	24-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
51--------------- Hamerly	0-10	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	25-40	5-20
	10-24	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	25-45	5-20
	24-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	25-45	5-20

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag-ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
54---------------- Lamoure	0-7	Silty clay loam	CL, CH, MH, ML	A-7	0	100	100	95-100	85-100	45-70	20-35
	7-25	Silty clay loam, silt loam.	CL, CH, MH, ML	A-7	0	100	100	90-100	85-100	40-70	15-35
	25-43	Silty clay loam, silt loam, loam.	CL, ML	A-6, A-7	0	95-100	95-100	90-100	75-100	30-50	10-20
	43-60	Stratified sandy loam to silty clay loam.	CL, SC	A-6, A-7	0	95-100	95-100	70-95	35-90	30-50	10-25
55---------------- LaDelle	0-33	Silty clay loam	CL, ML, MH	A-6, A-7	0	100	100	95-100	85-100	35-55	10-25
	33-45	Silt loam, silty clay loam.	CL, ML, MH, CH	A-6, A-7	0	100	100	90-100	75-100	25-55	10-25
	45-60	Stratified silt loam to clay loam.	CL, ML	A-4, A-6, A-7	0	100	100	90-100	75-100	25-50	5-25
57---------------- Fairdale	0-6	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	85-100	60-90	20-40	3-15
	6-60	Stratified very fine sandy loam to silty clay loam.	ML, CL, CL-ML	A-4, A-6	0	100	100	85-100	55-90	20-40	NP-20
58B-------------- Maddock	0-7	Fine sandy loam	SM	A-2, A-4	0	100	100	60-85	30-50	---	NP
	7-60	Loamy sand, fine sand, sand.	SM, SP-SM	A-2, A-3	0	100	100	60-95	5-35	---	NP
59, 59B---------- Overly	0-8	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-100	30-45	10-25
	8-31	Silty clay loam, silt loam, clay loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
	31-60	Stratified silt loam to silty clay.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
61*:											
Perella---------	0-16	Silty clay loam	CL	A-6, A-7	0	100	95-100	95-100	85-95	25-50	10-30
	16-26	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-7, A-6	0	100	95-100	95-100	80-100	25-45	5-25
	26-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-7, A-6	0	100	95-100	95-100	80-100	25-45	5-25
Bearden---------	0-9	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	80-95	25-55	10-30
	9-24	Silt loam, silty clay loam.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	25-55	10-30
	24-60	Silt loam, silty clay loam, loam.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	25-55	10-30
62*:											
Overly----------	0-8	Silt loam--------	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	85-100	25-45	5-25
	8-31	Silty clay loam, silt loam, clay loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
	31-60	Stratified silt loam to silty clay.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
Bearden---------	0-9	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	90-100	70-90	20-40	5-20
	9-24	Silt loam, silty clay loam.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	25-55	10-30
	24-60	Silt loam, silty clay loam, loam.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	25-55	10-30

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
63B*:											
Renshaw	0-7	Loam	ML, CL	A-4, A-6	0-5	95-100	90-100	70-100	50-75	30-40	5-15
	7-15	Loam, sandy clay loam, gravelly loam.	SM-SC, SC, ML, CL	A-4, A-6, A-7	0-5	95-100	55-100	45-90	35-70	25-45	3-15
	15-60	Gravelly loamy sand, very gravelly loamy sand, gravelly sand.	SW, SM, SW-SM, GW-GM	A-1	0-5	45-95	30-80	10-50	0-15	<25	NP-5
Sioux	0-7	Loam	ML, CL	A-4, A-6	0-5	95-100	85-100	70-90	55-75	30-40	5-15
	7-11	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	11-60	Gravelly sand, gravelly loamy sand.	GM, GP, SM, SP	A-1	0	25-75	10-60	5-35	0-25	<25	NP-5
63C: Sioux	0-7	Gravelly sandy loam.	SM, GM	A-4, A-2	0-5	60-90	50-80	45-70	25-50	20-35	NP-7
	7-11	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	11-60	Gravelly sand, gravelly loamy sand.	GM, GP, SM, SP	A-1	0	25-75	10-60	5-35	0-25	<25	NP-5
64*. Pits											
65*:											
Svea	0-18	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	18-28	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	28-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-85	20-50	5-30
Barnes	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-14	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	14-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
66*:											
Wyard	0-22	Loam	CL-ML, CL	A-4, A-6	0	95-100	95-100	85-100	60-90	25-40	5-20
	22-60	Loam, sandy loam, clay loam.	SM, ML, CL, SC	A-4, A-6, A-7	0-10	95-100	95-100	80-100	35-85	20-45	3-25
Hamerly	0-10	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-25
	10-24	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	24-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
67 Galchutt	0-17	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-95	30-65	20-35	NP-10
	17-27	Silt loam, loam, very fine sandy loam.	ML, CL, CL-ML	A-4, A-6	0	100	100	95-100	60-95	20-40	NP-20
	27-60	Silty clay, clay	CH	A-7	0	95-100	90-100	85-100	80-100	50-95	25-60
71 Vallers	0-7	Loam	OL, ML	A-4	0	95-100	90-100	80-90	50-80	30-40	4-10
	7-18	Clay loam, silty clay loam.	CL	A-6	0	95-100	90-97	80-95	50-80	30-40	11-20
	18-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-97	85-95	60-75	20-40	5-20
72 Wahpeton	0-33	Silty clay	CH	A-7	0	100	100	95-100	80-95	50-75	25-50
	33-60	Clay, silty clay, silty clay loam.	CH, CL	A-7, A-6	0	100	100	95-100	80-95	35-75	25-50

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
73---------------- Rauville	0-32	Silty clay loam	CL, CH, MH	A-6, A-7	0	100	100	90-100	85-100	35-60	15-28
	32-47	Silty clay loam, silt loam.	CL, CH, MH	A-6, A-7	0	100	100	90-100	85-100	35-60	15-28
	47-60	Stratified gravelly sand to clay loam.	SM, SC, CL, ML	A-2, A-4	0	80-100	65-95	50-85	15-70	<30	NP-10
76, 76B----------- Wyndmere	0-14	Silt loam---------	ML	A-4	0	100	100	85-95	50-70	---	NP
	14-23	Sandy loam, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	23-60	Fine sand, loamy fine sand, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-85	20-55	---	NP
77---------------- Vallers	0-7	Loam--------------	OL, ML	A-4	0	95-100	90-100	80-90	65-80	25-40	3-10
	7-18	Clay loam, loam	CL	A-6	0	95-100	90-100	90-95	70-80	30-40	10-20
	18-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-100	85-95	60-75	20-40	5-20
78B*: Svea-------------	0-18	Loam--------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	18-28	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	28-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-85	20-50	5-30
Buse--------------	0-7	Loam--------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-95	60-85	25-40	5-20
80*: Wyndmere---------	0-14	Loam--------------	ML	A-4	0	100	100	85-95	50-70	---	NP
	14-23	Sandy loam, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	23-60	Fine sand, loamy fine sand, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-85	20-55	---	NP
Tiffany----------	0-13	Loam--------------	ML, CL-ML, CL	A-4	0	100	100	85-95	50-80	15-35	NP-10
	13-60	Fine sandy loam, loamy fine sand, silt loam.	SM, ML	A-2, A-4	0	100	100	50-95	20-55	---	NP
82*: Glyndon----------	0-12	Silt loam---------	OL, ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	12-28	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
	28-60	Silt loam, very fine sand, very fine sandy loam.	ML, SM, SC, CL	A-4	0	100	100	85-100	35-75	10-30	NP-10
Tiffany----------	0-13	Silt loam---------	ML, CL-ML, CL	A-4	0	100	100	85-95	50-80	15-35	NP-10
	13-60	Fine sandy loam, loamy fine sand, silt loam.	SM, ML	A-2, A-4	0	100	100	50-95	20-55	---	NP
83*: Galchutt---------	0-17	Silty clay loam, loam.	CL	A-7, A-6	0	100	100	95-100	85-95	30-50	10-30
	17-25	Silt loam, loam, very fine sandy loam.	ML, CL, CL-ML	A-4, A-6	0	100	100	95-100	60-95	20-40	NP-20
	25-60	Silty clay, clay	CH	A-7	0	95-100	90-100	85-100	80-100	50-95	25-60

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
83*:											
Fargo-----------	0-10	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	30-50	11-25
	10-22	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	22-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
84*:											
Bearden---------	0-9	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	80-95	25-55	10-30
	9-24	Silt loam, silty clay loam.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	25-55	10-30
	24-60	Silt loam, silty clay loam, loam.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	25-55	10-30
Lindaas---------	0-11	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	75-95	30-50	11-25
	11-24	Silty clay, clay	CH	A-7	0	100	100	95-100	80-95	50-70	25-45
	24-43	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	95-100	75-95	30-50	11-25
	43-60	Silt loam, very fine sandy loam, silty clay loam.	CL, CL-ML	A-4, A-6	0	100	100	85-100	55-95	20-40	5-20
85--------------- Fairdale Variant	0-9	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	85-100	60-90	20-40	5-15
	9-22	Loam, silt loam, very fine sandy loam.	ML, CL, CL-ML	A-4, A-6	0	100	100	85-100	55-90	20-40	5-15
	22-60	Silty clay, clay, silty clay loam.	CL, CH	A-7	0	100	100	95-100	85-100	45-70	20-40

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
1*:									
Fargo-----------	0-10	0.06-0.2	0.15-0.18	6.6-7.8	<2	High------	0.32	5	4
	10-22	0.06-0.2	0.14-0.17	6.6-7.8	<2	High------	0.32		
	22-60	0.06-0.2	0.14-0.17	7.9-8.4	<2	High------	0.32		
Enloe-----------	0-15	0.06-0.2	0.15-0.18	5.6-7.3	<2	High------	0.32	3	4
	15-42	0.06-0.2	0.14-0.17	6.1-7.8	<2	High------	0.32		
	42-60	0.06-0.2	0.13-0.16	7.4-7.8	<2	High------	0.32		
2---------------- Tonka	0-15	0.6-2.0	0.18-0.23	5.6-7.3	<2	Low-------	0.32	5	6
	15-40	0.06-0.2	0.14-0.19	5.6-7.3	<2	High------	0.43		
	40-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		
3---------------- Parnell	0-18	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	7
	18-40	0.06-0.2	0.13-0.19	6.6-7.8	<2	High------	0.28		
	40-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High------	0.28		
4---------------- Perella	0-18	0.2-2.0	0.18-0.23	6.6-7.8	<2	Moderate	0.28	5	7
	18-30	0.2-0.6	0.15-0.22	6.6-7.8	<2	Moderate	0.28		
	30-60	0.2-0.6	0.16-0.22	7.4-8.4	<2	Moderate	0.28		
5---------------- Dovray	0-25	0.06-0.6	0.13-0.16	6.1-7.8	<2	High------	0.28	5	4
	25-57	<0.2	0.10-0.14	6.6-7.8	<2	High------	0.28		
	57-60	<0.6	0.10-0.18	6.6-8.4	<2	High------	0.28		
6---------------- Parnell	0-18	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	7
	18-40	0.06-0.2	0.13-0.19	6.6-7.8	<2	High------	0.28		
	40-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High------	0.28		
9C*:									
Nutley----------	0-8	0.06-0.2	0.10-0.16	7.4-8.4	<2	High------	0.28	5	4
	8-60	<0.2	0.08-0.15	7.4-8.4	<2	High------	0.28		
Fargo-----------	0-10	0.06-0.2	0.15-0.18	6.6-7.8	<2	High------	0.32	5	4
	10-22	0.06-0.2	0.14-0.17	6.6-7.8	<2	High------	0.32		
	22-60	0.06-0.2	0.14-0.17	7.9-8.4	<2	High------	0.32		
10*:									
Fargo-----------	0-10	0.06-0.2	0.15-0.18	6.6-7.8	<2	High------	0.32	5	4
	10-22	0.06-0.2	0.14-0.17	6.6-7.8	<2	High------	0.32		
	22-60	0.06-0.2	0.14-0.17	7.9-8.4	<2	High------	0.32		
Ryan------------	0-4	<0.06	0.15-0.18	7.4-8.4	<2	High------	0.28	3	4
	4-60	<0.06	0.10-0.14	7.4-9.0	4-16	High------	0.28		
11--------------- Nahon	0-6	0.2-0.6	0.19-0.22	5.6-7.3	<2	Moderate	0.28	3	6
	6-8	0.2-0.6	0.19-0.22	5.6-7.3	<2	Moderate	0.28		
	8-18	<0.06	0.10-0.15	6.6-9.0	<2	High------	0.28		
	18-60	0.06-0.2	0.14-0.17	7.9-9.0	4-16	Moderate	0.43		
12*:									
Hegne-----------	0-7	<0.2	0.14-0.17	7.4-8.4	<2	High------	0.32	5	4
	7-31	<0.2	0.13-0.16	7.4-8.4	<4	High------	0.32		
	31-60	<0.06	0.09-0.16	7.4-8.4	<4	High------	0.32		
Enloe-----------	0-15	0.06-0.2	0.15-0.18	5.6-7.3	<2	High------	0.32	3	4
	15-42	0.06-0.2	0.14-0.17	6.1-7.8	<2	High------	0.32		
	42-60	0.06-0.2	0.13-0.16	7.4-7.8	<2	High------	0.32		

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
14B*, 14C*, 14D*:									
Barnes----------	0-7	0.6-2.0	0.13-0.24	6.1-7.8	<2	Low--------	0.28	5	6
	7-14	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	14-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Buse------------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
15*:									
Emrick----------	0-16	0.6-2.0	0.20-0.24	6.6-7.3	<2	Low--------	0.28	5	5
	16-23	0.6-2.0	0.17-0.19	6.6-7.3	<2	Low--------	0.28		
	23-60	0.6-2.0	0.11-0.21	7.4-8.4	<2	Low--------	0.37		
Heimdal---------	0-6	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low--------	0.28	5	5
	6-15	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low--------	0.28		
	15-48	0.6-2.0	0.11-0.21	7.9-8.4	<2	Low--------	0.37		
	48-60	2.0-20	0.06-0.13	7.4-8.4	<2	Low--------	0.17		
15B*:									
Heimdal---------	0-6	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low--------	0.28	5	5
	6-15	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low--------	0.28		
	15-48	0.6-2.0	0.11-0.21	7.9-8.4	<2	Low--------	0.37		
	48-60	2.0-20	0.06-0.13	7.4-8.4	<2	Low--------	0.17		
Emrick----------	0-16	0.6-2.0	0.20-0.24	6.6-7.3	<2	Low--------	0.28	5	5
	16-23	0.6-2.0	0.17-0.19	6.6-7.3	<2	Low--------	0.28		
	23-60	0.6-2.0	0.11-0.21	7.4-8.4	<2	Low--------	0.37		
15C*:									
Heimdal---------	0-6	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low--------	0.28	5	5
	6-15	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low--------	0.28		
	15-48	0.6-2.0	0.11-0.21	7.9-8.4	<2	Low--------	0.37		
	48-60	2.0-20	0.06-0.13	7.4-8.4	<2	Low--------	0.17		
Esmond----------	0-6	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low--------	0.28	5	4L
	6-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Low--------	0.37		
15D*:									
Esmond----------	0-6	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low--------	0.28	5	4L
	6-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Low--------	0.37		
Heimdal---------	0-6	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low--------	0.28	5	5
	6-15	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low--------	0.28		
	15-48	0.6-2.0	0.11-0.21	7.9-8.4	<2	Low--------	0.37		
	48-60	2.0-20	0.06-0.13	7.4-8.4	<2	Low--------	0.17		
16B*, 16C*, 16D*:									
Barnes----------	0-7	0.6-2.0	0.13-0.24	6.1-7.8	<2	Low--------	0.28	5	6
	7-14	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	14-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Sioux-----------	0-7	0.6-2.0	0.18-0.20	6.6-8.4	<2	Low--------	0.28	2	5
	7-11	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low--------	0.20		
	11-60	>6.0	0.03-0.06	7.4-8.4	<2	Low--------	0.10		
17B*:									
Barnes----------	0-7	0.6-2.0	0.13-0.24	6.1-7.8	<2	Low--------	0.28	5	6
	7-14	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	14-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Svea------------	0-18	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	6
	18-28	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	28-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
18--------------- Bearden	0-9	0.2-0.6	0.17-0.23	7.4-8.4	<4	Moderate	0.28	5	4L
	9-24	0.2-2.0	0.16-0.22	7.4-8.4	<4	Moderate	0.28		
	24-60	0.06-2.0	0.16-0.22	7.4-8.4	<8	Moderate	0.43		

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
19----------------	0-8	0.2-0.6	0.13-0.16	7.4-9.0	4-16	Moderate	0.32	5	4L
Colvin	8-60	0.06-2.0	0.11-0.15	7.4-9.0	4-16	Moderate	0.32		
20----------------	0-9	0.6-2.0	0.14-0.16	7.4-7.8	4-16	Moderate	0.32	5	4L
Bearden	9-24	0.06-2.0	0.14-0.16	7.9-8.4	4-16	Moderate	0.32		
	24-60	0.06-2.0	0.11-0.13	7.9-8.4	4-16	Moderate	0.32		
22*:									
Bearden----------	0-9	0.2-0.6	0.17-0.23	7.4-8.4	<4	Moderate	0.28	5	4L
	9-24	0.2-2.0	0.16-0.22	7.4-8.4	<4	Moderate	0.28		
	24-60	0.06-2.0	0.16-0.22	7.4-8.4	<8	Moderate	0.43		
Perella----------	0-16	0.2-2.0	0.18-0.23	6.6-7.8	<2	Moderate	0.28	5	7
	16-26	0.2-0.6	0.15-0.22	6.6-7.8	<2	Moderate	0.28		
	26-60	0.2-0.6	0.16-0.22	7.4-8.4	<2	Moderate	0.28		
23F*:									
Buse-------------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Barnes-----------	0-7	0.6-2.0	0.13-0.24	6.1-7.8	<2	Low--------	0.28	5	6
	7-14	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	14-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
24, 25------------	0-7	0.06-0.6	0.15-0.18	7.4-8.4	<2	High-------	0.32	5	4
Cashel	7-60	0.06-0.6	0.13-0.17	7.4-8.4	<2	High-------	0.32		
26----------------	0-8	0.2-0.6	0.20-0.22	7.4-9.0	<2	Moderate	0.32	5	4L
Colvin	8-36	0.06-2.0	0.16-0.20	7.4-9.0	<2	Moderate	0.32		
	36-60	0.06-2.0	0.15-0.20	7.4-9.0	<2	Moderate	0.32		
27----------------	0-14	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.28	4	4L
Divide	14-30	0.6-2.0	0.16-0.19	7.9-8.4	<2	Low--------	0.28		
	30-60	>6.0	0.03-0.07	7.9-8.4	<2	Low--------	0.10		
29----------------	0-10	0.06-0.2	0.15-0.18	6.6-7.8	4-16	High-------	0.32	5	4
Fargo	10-22	0.06-0.2	0.14-0.17	6.6-7.8	4-16	High-------	0.32		
	22-60	0.06-0.2	0.14-0.17	7.9-8.4	4-16	High-------	0.32		
31B---------------	0-11	2.0-6.0	0.13-0.18	6.6-7.3	<2	Low--------	0.20	5	3
Embden	11-24	2.0-6.0	0.12-0.17	6.6-7.8	<2	Low--------	0.20		
	24-40	2.0-6.0	0.06-0.16	7.4-8.4	<2	Low--------	0.20		
	40-60	2.0-6.0	0.03-0.07	7.4-8.4	<2	Low--------	0.10		
32----------------	0-10	0.06-0.2	0.15-0.18	6.6-7.8	<2	High-------	0.32	5	4
Fargo	10-22	0.06-0.2	0.14-0.17	6.6-7.8	<2	High-------	0.32		
	22-60	0.06-0.2	0.14-0.17	7.9-8.4	<2	High-------	0.32		
35----------------	0-6	0.6-2.0	0.20-0.24	7.4-7.8	<2	Low--------	0.32	5	6
Fairdale	6-60	0.6-2.0	0.17-0.23	7.4-8.4	<2	Moderate	0.32		
36, 37------------	0-10	0.06-0.2	0.15-0.18	6.6-7.8	<2	High-------	0.32	5	4
Fargo	10-22	0.06-0.2	0.14-0.17	6.6-7.8	<2	High-------	0.32		
	22-60	0.06-0.2	0.14-0.17	7.9-8.4	<2	High-------	0.32		
38----------------	0-10	0.06-0.2	0.18-0.23	6.6-7.8	<2	Moderate	0.32	5	7
Fargo	10-22	0.06-0.2	0.14-0.17	6.6-7.8	<2	High-------	0.32		
	22-60	0.06-0.2	0.14-0.17	7.9-8.4	<2	High-------	0.32		
39----------------	0-17	0.6-2.0	0.20-0.24	6.1-7.3	<2	Moderate	0.32	4	6
Galchutt	17-25	0.6-2.0	0.17-0.22	6.6-7.3	<2	Moderate	0.32		
	25-60	0.06-0.2	0.13-0.16	6.6-7.8	<2	High-------	0.32		
40*:									
Fargo------------	0-10	0.06-0.2	0.15-0.18	6.6-7.8	<2	High-------	0.32	5	4
	10-22	0.06-0.2	0.14-0.17	6.6-7.8	<2	High-------	0.32		
	22-60	0.06-0.2	0.14-0.17	7.9-8.4	<2	High-------	0.32		

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
40*:									
Hegne-----------	0-7	<0.2	0.14-0.17	7.4-8.4	<2	High------	0.32	5	4
	7-31	<0.2	0.13-0.16	7.4-8.4	<4	High------	0.32		
	31-60	<0.06	0.09-0.16	7.4-8.4	<4	High------	0.32		
41*:									
Hegne-----------	0-7	0.2-0.6	0.17-0.22	7.4-8.4	<2	Moderate	0.32	5	4L
	7-31	<0.2	0.13-0.16	7.4-8.4	<4	High------	0.32		
	31-60	<0.06	0.09-0.16	7.4-8.4	<4	High------	0.32		
Fargo-----------	0-10	0.06-0.2	0.18-0.23	6.6-7.8	<2	Moderate	0.32	5	7
	10-22	0.06-0.2	0.14-0.17	6.6-7.8	<2	High------	0.32		
	22-60	0.06-0.2	0.14-0.17	7.9-8.4	<2	High------	0.32		
43--------------- Gardena	0-11	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	0.28	5	5
	11-60	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low-------	0.43		
46*:									
Gardena---------	0-11	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	0.28	5	5
	11-60	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low-------	0.43		
Glyndon---------	0-12	0.6-2.0	0.20-0.23	7.4-9.0	<4	Low-------	0.28	4	4L
	12-28	0.6-6.0	0.17-0.20	7.9-9.0	<4	Low-------	0.28		
	28-60	2.0-20	0.15-0.19	7.4-8.4	<4	Low-------	0.28		
47--------------- Fargo	0-10	0.06-0.2	0.15-0.18	6.6-7.8	<2	High------	0.32	5	4
	10-22	0.06-0.2	0.14-0.17	6.6-7.8	<2	High------	0.32		
	22-60	0.06-0.2	0.14-0.17	7.9-8.4	<2	High------	0.32		
48--------------- Glyndon	0-12	0.6-2.0	0.20-0.23	7.4-9.0	<4	Low-------	0.28	4	4L
	12-28	0.6-6.0	0.17-0.20	7.9-9.0	<4	Low-------	0.28		
	28-60	2.0-20	0.15-0.19	7.4-8.4	<4	Low-------	0.28		
49--------------- Glyndon	0-12	0.6-2.0	0.13-0.15	7.4-9.0	4-16	Low-------	0.28	4	4L
	12-28	2.0-6.0	0.11-0.13	7.9-9.0	4-16	Low-------	0.28		
	28-60	2.0-20	0.09-0.12	7.9-8.4	4-16	Low-------	0.28		
50*:									
Hamerly---------	0-10	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	10-24	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	24-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Tonka-----------	0-15	0.6-2.0	0.18-0.23	5.6-7.3	<2	Low-------	0.32	5	6
	15-40	0.06-0.2	0.14-0.19	5.6-7.3	<2	High------	0.43		
	40-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		
50B-------------- Hamerly	0-10	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	10-24	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	24-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
51--------------- Hamerly	0-10	0.6-2.0	0.12-0.15	7.4-8.4	4-16	Moderate	0.28	5	4L
	10-24	0.6-2.0	0.10-0.13	7.4-8.4	4-16	Moderate	0.28		
	24-60	0.2-2.0	0.10-0.13	7.4-8.4	4-16	Moderate	0.37		
54--------------- Lamoure	0-7	0.6-2.0	0.19-0.22	7.4-8.4	<4	Moderate	0.28	5	4L
	7-25	0.6-2.0	0.17-0.20	7.4-8.4	<4	Moderate	0.28		
	25-43	0.6-2.0	0.17-0.20	7.4-8.4	<4	Moderate	0.28		
	43-60	0.6-2.0	0.09-0.18	7.4-8.4	<4	Low-------	0.28		
55--------------- LaDelle	0-33	0.6-2.0	0.19-0.22	6.6-7.8	<2	Moderate	0.28	5	7
	33-45	0.6-2.0	0.18-0.22	7.4-8.4	<4	Moderate	0.28		
	45-60	0.6-2.0	0.18-0.22	7.4-8.4	<4	Moderate	0.28		
57--------------- Fairdale	0-6	0.6-2.0	0.20-0.24	7.4-7.8	<2	Low-------	0.32	5	6
	6-60	0.6-2.0	0.17-0.23	7.4-8.4	<2	Moderate	0.32		

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
58B--------------- Maddock	0-7 7-60	6.0-20 6.0-20	0.13-0.18 0.05-0.13	6.6-7.8 6.6-8.4	<2 <2	Low-------- Low--------	0.17 0.17	5	3
59, 59B----------- Overly	0-8 8-31 31-60	0.2-0.6 0.2-0.6 0.06-0.6	0.17-0.23 0.17-0.22 0.13-0.22	6.6-7.8 7.4-8.4 7.9-8.4	<2 <2 <2	Moderate Moderate Moderate	0.32 0.32 0.32	5	7
61*: Perella----------	0-16 16-26 26-60	0.2-2.0 0.2-0.6 0.2-0.6	0.18-0.23 0.15-0.22 0.16-0.22	6.6-7.8 6.6-7.8 7.4-8.4	<2 <2 <2	Moderate Moderate Moderate	0.28 0.28 0.28	5	7
Bearden----------	0-9 9-24 24-60	0.2-0.6 0.2-2.0 0.06-2.0	0.17-0.23 0.16-0.22 0.16-0.22	7.4-8.4 7.4-8.4 7.4-8.4	<4 <4 <8	Moderate Moderate Moderate	0.28 0.28 0.43	5	4L
62*: Overly-----------	0-8 8-31 31-60	0.2-0.6 0.2-0.6 0.06-0.6	0.22-0.24 0.17-0.22 0.13-0.22	6.6-7.8 7.4-8.4 7.9-8.4	<2 <2 <2	Moderate Moderate Moderate	0.32 0.32 0.32	5	6
Bearden----------	0-9 9-24 24-60	0.6-2.0 0.2-2.0 0.06-2.0	0.20-0.24 0.16-0.22 0.16-0.22	7.4-8.4 7.4-8.4 7.4-8.4	<4 <4 <8	Moderate Moderate Moderate	0.28 0.28 0.43	5	4L
63B*: Renshaw----------	0-7 7-15 15-60	0.6-2.0 0.6-6.0 >6.0	0.18-0.20 0.11-0.18 0.03-0.06	6.1-7.8 6.6-7.8 6.6-8.4	<2 <2 <2	Low-------- Low-------- Low--------	0.28 0.28 0.10	3	6
Sioux------------	0-7 7-11 11-60	0.6-2.0 2.0-6.0 >6.0	0.18-0.20 0.10-0.15 0.03-0.06	6.6-8.4 7.4-8.4 7.4-8.4	<2 <2 <2	Low-------- Low-------- Low--------	0.28 0.20 0.10	2	5
63C--------------- Sioux	0-7 7-11 11-60	2.0-6.0 2.0-6.0 >6.0	0.10-0.15 0.10-0.15 0.03-0.06	6.6-8.4 7.4-8.4 7.4-8.4	<2 <2 <2	Low-------- Low-------- Low--------	0.20 0.20 0.10	2	8
64*. Pits									
65*: Svea-------------	0-18 18-28 28-60	0.6-2.0 0.6-2.0 0.2-2.0	0.20-0.24 0.17-0.22 0.14-0.19	6.6-7.8 6.6-7.8 7.4-8.4	<2 <2 <2	Low-------- Moderate Moderate	0.28 0.28 0.37	5	6
Barnes-----------	0-7 7-14 14-60	0.6-2.0 0.6-2.0 0.2-0.6	0.13-0.24 0.15-0.19 0.14-0.19	6.1-7.8 6.1-7.8 7.4-8.4	<2 <4 <4	Low-------- Moderate Moderate	0.28 0.28 0.37	5	6
66*: Wyard------------	0-22 22-60	0.6-2.0 0.6-2.0	0.20-0.24 0.14-0.22	6.6-7.8 7.4-8.4	<2 <2	Moderate Moderate	0.28 0.37	5	6
Hamerly----------	0-10 10-24 24-60	0.6-2.0 0.6-2.0 0.2-2.0	0.17-0.22 0.15-0.19 0.14-0.19	6.6-8.4 7.4-8.4 7.4-8.4	<2 <2 <2	Moderate Moderate Moderate	0.28 0.28 0.37	5	4L
67---------------- Galchutt	0-17 17-27 27-60	2.0-6.0 0.6-2.0 0.06-0.2	0.13-0.18 0.17-0.22 0.13-0.16	6.1-7.3 6.6-7.3 6.6-7.8	<2 <2 <2	Low-------- Moderate High-------	0.20 0.32 0.32	4	3
71---------------- Vallers	0-7 7-18 18-60	0.6-2.0 0.2-0.6 0.2-0.6	0.22-0.24 0.15-0.19 0.17-0.19	7.4-8.4 7.9-8.4 7.4-8.4	<4 <4 <4	Low-------- Moderate Low--------	0.28 0.28 0.28	5	4L

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
72------------- Wahpeton	0-33	0.2-2.0	0.14-0.18	6.1-7.8	<2	High------	0.28	5	4
	33-60	0.2-2.0	0.13-0.17	7.4-7.8	<2	High------	0.28		
73------------- Rauville	0-32	0.2-2.0	0.19-0.22	7.4-8.4	<2	Moderate	0.28	5	8
	32-47	0.2-2.0	0.17-0.20	7.4-8.4	<4	Moderate	0.28		
	47-60	2.0-6.0	0.08-0.15	7.4-8.4	<4	Low-------	0.10		
76, 76B---------- Wyndmere	0-14	2.0-6.0	0.20-0.22	7.9-8.4	<2	Low-------	0.28	5	4L
	14-23	2.0-6.0	0.12-0.17	7.9-8.4	<2	Low-------	0.20		
	23-60	2.0-6.0	0.06-0.16	7.9-8.4	<2	Low-------	0.20		
77------------- Vallers	0-7	0.6-2.0	0.14-0.16	7.4-8.4	4-16	Low-------	0.28	5	4L
	7-18	0.2-0.6	0.10-0.13	7.9-8.4	4-16	Low-------	0.28		
	18-60	0.2-0.6	0.11-0.13	7.4-8.4	4-16	Low-------	0.28		
78B*:									
Svea-----------	0-18	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	0.28	5	6
	18-28	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	28-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Buse-----------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
80*:									
Wyndmere--------	0-14	2.0-6.0	0.20-0.22	7.9-8.4	<2	Low-------	0.28	5	4L
	14-23	2.0-6.0	0.12-0.17	7.9-8.4	<2	Low-------	0.20		
	23-60	2.0-6.0	0.06-0.16	7.9-8.4	<2	Low-------	0.20		
Tiffany---------	0-13	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low-------	0.28	5	5
	13-60	0.6-6.0	0.10-0.17	6.6-7.8	<2	Low-------	0.20		
82*:									
Glyndon---------	0-12	0.6-2.0	0.20-0.23	7.4-9.0	<4	Low-------	0.28	4	4L
	12-28	0.6-6.0	0.17-0.20	7.9-9.0	<4	Low-------	0.28		
	28-60	2.0-20	0.15-0.19	7.4-8.4	<4	Low-------	0.28		
Tiffany---------	0-13	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low-------	0.28	5	5
	13-60	0.6-6.0	0.10-0.17	6.6-7.8	<2	Low-------	0.20		
83*:									
Galchutt--------	0-17	0.6-2.0	0.18-0.23	6.1-7.3	<2	Moderate	0.32	4	7
	17-25	0.6-2.0	0.17-0.22	6.6-7.3	<2	Moderate	0.32		
	25-60	0.06-0.2	0.13-0.16	6.6-7.8	<2	High------	0.32		
Fargo-----------	0-10	0.06-0.2	0.18-0.23	6.6-7.8	<2	Moderate	0.32	5	7
	10-22	0.06-0.2	0.14-0.17	6.6-7.8	<2	High------	0.32		
	22-60	0.06-0.2	0.14-0.17	7.9-8.4	<2	High------	0.32		
84*:									
Bearden---------	0-9	0.2-0.6	0.17-0.23	7.4-8.4	<4	Moderate	0.28	5	4L
	9-24	0.2-2.0	0.16-0.22	7.4-8.4	<4	Moderate	0.28		
	24-60	0.06-2.0	0.16-0.22	7.4-8.4	<8	Moderate	0.43		
Lindaas---------	0-11	0.6-2.0	0.18-0.23	6.6-7.3	<2	Moderate	0.32	3	6
	11-24	0.06-0.2	0.14-0.17	6.6-7.8	<2	High------	0.32		
	24-43	0.2-0.6	0.16-0.22	7.9-8.4	<2	Moderate	0.43		
	43-60	0.2-2.0	0.17-0.22	7.9-8.4	<2	Moderate	0.43		
85------------- Fairdale Variant	0-9	0.6-2.0	0.20-0.24	7.4-8.4	<2	Low-------	0.32	5	6
	9-22	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low-------	0.32		
	22-60	0.06-0.2	0.13-0.15	6.6-8.4	<2	High------	0.32		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
1*:										
Fargo	D	None	---	---	0-3.0	Apparent	Sep-Jun	High	High	Low.
Enloe**	D	None	---	---	+1-1.0	Apparent	Apr-Jun	High	High	Low.
2** Tonka	C/D	None	---	---	+.5-1.0	Apparent	Apr-Jun	High	High	Low.
3** Parnell	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec	High	High	Low.
4** Perella	B/D	None	---	---	+1-1.0	Apparent	Apr-Jul	High	High	Low.
5** Dovray	C/D	None	---	---	+2-1.0	Apparent	Jan-Dec	Moderate	High	Low.
6** Parnell	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec	High	High	Low.
9C*:										
Nutley	C	None	---	---	>6.0	---	---	Moderate	High	Low.
Fargo	D	Rare	---	---	0-3.0	Apparent	Sep-Jun	High	High	Low.
10*:										
Fargo	D	Occasional	Brief	Jan-Apr	0-3.0	Apparent	Sep-Jun	High	High	Low.
Ryan	D	Occasional	Brief to long.	Mar-Jun	0-1.0	Apparent	Apr-Jul	Moderate	High	Moderate.
11 Nahon	D	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.
12*:										
Hegne	D	None	---	---	1.0-2.5	Apparent	Apr-Jul	Moderate	High	Low.
Enloe**	D	None	---	---	+1-1.0	Apparent	Apr-Jun	High	High	Low.
14B*, 14C*, 14D*:										
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
15*:										
Emrick	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Heimdal	B	None	---	---	>6.0	---	---	Moderate	High	Low.
15B*:										
Heimdal	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Emrick	B	None	---	---	>6.0	---	---	Moderate	High	Low.
15C*:										
Heimdal	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Esmond	B	None	---	---	>6.0	---	---	Moderate	High	Low.
15D*:										
Esmond	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Heimdal	B	None	---	---	>6.0	---	---	Moderate	High	Low.

See footnotes at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
16B*, 16C*, 16D*:										
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Sioux	A	None	---	---	>6.0	---	---	Low	Low	Low.
17B*:										
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Svea	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Low.
18 Bearden	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	High	High	Low.
19 Colvin	C	Occasional	Long	Apr-Jun	0-2.0	Apparent	Apr-Jul	High	High	Moderate.
20 Bearden	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	High	High	Moderate.
22*:										
Bearden	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	High	High	Low.
Perella	B	None	---	---	2.0-4.0	Apparent	Apr-Jun	High	High	Low.
23F*:										
Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
24, 25 Cashel	C	Occasional	Brief	Mar-May	1.0-3.0	Apparent	Apr-Jul	Moderate	High	Low.
26 Colvin	C/D	None	---	---	0-1.0	Apparent	Apr-Jul	High	High	Low.
27 Divide	B	None	---	---	2.5-5.0	Apparent	Apr-Jun	Moderate	High	Low.
29 Fargo	D	Occasional	Brief	Jan-Apr	0-3.0	Apparent	Sep-Jun	High	High	Low.
31B Embden	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Low.
32 Fargo	D	Rare	---	---	0-3.0	Apparent	Sep-Jun	High	High	Low.
35 Fairdale	B	Occasional	Brief	Mar-Jun	>6.0	---	---	Moderate	Moderate	Low.
36 Fargo	D	Occasional	Brief	Jan-Apr	0-3.0	Apparent	Sep-Jun	High	High	Low.
37** Fargo	D	None	---	---	+.5-1.0	Apparent	Jan-Dec	High	High	Low.
38 Fargo	D	Rare	---	---	0-3.0	Apparent	Sep-Jun	High	High	Low.
39 Galchutt	C	None	---	---	1.0-3.0	Perched	Apr-Jun	High	High	Low.
40*:										
Fargo	D	Occasional	Brief	Jan-Apr	0-3.0	Apparent	Sep-Jun	High	High	Low.
Hegne	D	Rare	---	---	1.0-2.5	Apparent	Apr-Jul	Moderate	High	Low.
41*:										
Hegne	D	Rare	---	---	1.0-2.5	Apparent	Apr-Jul	Moderate	High	Low.

See footnotes at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
41*:										
Fargo------------	D	Occasional	Brief-----	Jan-Apr	0-3.0	Apparent	Sep-Jun	High-----	High-----	Low.
43---------------- Gardena	B	None--------	---	---	4.0-6.0	Apparent	Apr-Jun	High-----	Moderate	Low.
46*:										
Gardena----------	B	None--------	---	---	4.0-6.0	Apparent	Apr-Jun	High-----	Moderate	Low.
Glyndon----------	B	None--------	---	---	2.5-6.0	Apparent	Apr-Jul	High-----	High-----	Low.
47---------------- Fargo	D	Occasional	Brief-----	Jan-Apr	0-3.0	Apparent	Sep-Jun	High-----	High-----	Low.
48---------------- Glyndon	B	None--------	---	---	2.5-6.0	Apparent	Apr-Jul	High-----	High-----	Low.
49---------------- Glyndon	B	None--------	---	---	2.5-6.0	Apparent	Apr-Jul	High-----	High-----	Moderate.
50*:										
Hamerly----------	C	None--------	---	---	2.0-4.0	Apparent	Apr-Jun	High-----	High-----	Low.
Tonka**----------	C/D	None--------	---	---	+.5-1.0	Apparent	Apr-Jun	High-----	High-----	Low.
50B--------------- Hamerly	C	None--------	---	---	2.0-4.0	Apparent	Apr-Jun	High-----	High-----	Low.
51---------------- Hamerly	C	None--------	---	---	2.0-4.0	Apparent	Sep-Jun	High-----	High-----	Moderate.
54---------------- Lamoure	C	Occasional	Brief-----	Mar-Oct	0-2.0	Apparent	Oct-Jun	High-----	High-----	Moderate.
55---------------- LaDelle	B	Occasional	Brief-----	Apr-Jun	4.0-6.0	Apparent	Oct-Jun	High-----	High-----	Low.
57---------------- Fairdale	B	Frequent----	Brief-----	Mar-Jun	>6.0	---	---	Moderate	Moderate	Low.
58B--------------- Maddock	A	None--------	---	---	>6.0	---	---	Low------	Moderate	Low.
59, 59B----------- Overly	C	None--------	---	---	4.0-6.0	Apparent	Apr-Jun	High-----	High-----	Low.
61*:										
Perella----------	B	None--------	---	---	2.0-4.0	Apparent	Apr-Jun	High-----	High-----	Low.
Bearden----------	C	None--------	---	---	2.0-4.0	Apparent	Apr-Jun	High-----	High-----	Low.
62*:										
Overly-----------	C	None--------	---	---	4.0-6.0	Apparent	Apr-Jun	High-----	High-----	Low.
Bearden----------	C	None--------	---	---	2.0-4.0	Apparent	Apr-Jun	High-----	High-----	Low.
63B*:										
Renshaw----------	B	None--------	---	---	>6.0	---	---	Low------	Moderate	Low.
Sioux------------	A	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
63C--------------- Sioux	A	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
64*. Pits										
65*:										
Svea-------------	B	None--------	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High-----	Low.

See footnotes at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
65*:										
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
66*:										
Wyard	B	None	---	---	1.0-3.0	Apparent	Mar-Jun	High	High	Low.
Hamerly	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	High	High	Low.
67 Galchutt	C	None	---	---	1.0-3.0	Perched	Apr-Jun	High	High	Low.
71 Vallers	C	None	---	---	1.0-2.5	Apparent	Nov-Jun	High	High	Low.
72 Wahpeton	C	Occasional	Brief	Mar-Jun	>6.0	---	---	High	High	Low.
73 Rauville	D	Frequent	Brief	Mar-Oct	0-2.0	Apparent	Jan-Dec	High	High	Moderate.
76, 76B Wyndmere	B	None	---	---	2.0-5.0	Apparent	Sep-Jun	High	High	Low.
77 Vallers	C	None	---	---	0-1.0	Apparent	Apr-Jul	High	High	Moderate.
78B*:										
Svea	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Low.
Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
80*:										
Wyndmere	B	None	---	---	2.0-5.0	Apparent	Sep-Jun	High	High	Low.
Tiffany**	B/D	None	---	---	+1-3.0	Apparent	Apr-Jun	High	High	Low.
82*:										
Glyndon	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	High	High	Low.
Tiffany**	B/D	None	---	---	+1-3.0	Apparent	Apr-Jun	High	High	Low.
83*:										
Galchutt	C	None	---	---	1.0-3.0	Perched	Apr-Jun	High	High	Low.
Fargo	D	None	---	---	0-3.0	Apparent	Sep-Jun	High	High	Low.
84*:										
Bearden	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	High	High	Low.
Lindaas**	C/D	None	---	---	+1-2.0	Apparent	Apr-Jun	High	High	Low.
85 Fairdale Variant	C	Rare	---	---	2.0-4.0	Perched	Apr-Jun	High	Moderate	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

** In the "High water table--Depth" column, a plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

TABLE 16.--ENGINEERING INDEX TEST DATA

[Dashes indicate data were not available]

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution								Liquid limit	Plasticity index	Moisture density	
			Percentage passing sieve--					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			Maximum density	Optimum moisture
											Pct		Lb/ft^3	Pct
Barnes loam: (S79ND-017-009)														
Bw------ 7 to 11	A-6(09)	CL	98	93	89	84	69	--	24	--	34	16	114	16
C------- 15 to 60	A-6(07)	CL	100	100	100	90	71	--	20	--	30	11	107	18
Buse loam: (S79ND-017-015)														
C------- 11 to 60	A-6(12)	CL	98	98	97	94	84	--	34	--	39	19	97	24
Cashel silty clay: (S79ND-017-001)														
Ab1----- 10 to 25	A-7-5(20)	MH	100	99	98	98	97	--	49	--	65	31	89	26
C3------ 32 to 42	A-7-6(20)	CH	100	100	100	100	100	--	59	--	59	33	95	24
Fairdale Variant silt loam: (S80ND-017-007)														
C------- 9 to 22	A-6(08)	CL	100	100	100	91	77	--	23	--	32	10	114	15
2Bwb---- 29 to 47	A-7-6(20)	CH	100	100	100	100	96	--	48	--	61	33	97	24
Fargo silty clay: (S80ND-017-009)														
Bw------ 7 to 18	A-7-6(20)	CH	100	100	100	100	99	--	75	--	75	46	97	23
C------- 18 to 60	A-7-5(20)	CH	100	100	100	100	98	--	66	--	67	36	99	22
Galchutt silt loam: (S79ND-017-007)														
2Bt----- 35 to 42	A-7-6(20)	CH	100	100	100	100	99	--	79	--	84	54	90	26
2C------ 42 to 60	A-7-5(20)	CH	97	95	93	92	92	--	65	--	91	56	94	25
Hamerly loam: (S79ND-017-008)														
Ck------ 11 to 18	A-6(08)	CL	100	99	99	85	63	--	30	--	35	15	113	16
C------- 28 to 60	A-4(05)	CL-ML	100	99	98	91	62	--	14	--	22	05	112	16
Hegne silty clay: (S80ND-017-029)														
C------- 19 to 42	A-7-6(20)	CH	100	100	100	100	98	--	66	--	64	39	103	20
LaDelle silty clay loam: (S79ND-017-005)														
Bw------ 14 to 33	A-7-6(16)	MH	100	100	100	99	97	--	33	--	53	24	99	23
C2------ 44 to 60	A-4(08)	CL	100	100	100	99	75	--	22	--	27	08	113	16

TABLE 16.--ENGINEERING INDEX TEST DATA--Continued

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution								Liquid limit	Plasticity index	Moisture density	
			Percentage passing sieve--					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			Maximum density	Optimum moisture
											Pct		Lb/ft3	Pct
Perella silty clay loam: (S79ND-017-003)														
Bg------ 13 to 19	A-7-6(12)	CL	100	100	99	99	98	--	31	--	40	20	105	19
Cg------ 30 to 40	A-6(09)	CL	100	100	100	100	99	--	25	--	36	12	100	22
Svea loam: (S79ND-017-400)														
Bw------ 12 to 23	A-6(08)	CL	100	100	100	94	73	--	20	--	30	12	113	16
C------- 31 to 60	A-6(10)	CL	100	99	98	95	81	--	20	--	36	16	105	19
Wyard loam: (S79ND-017-020)														
Bw1----- 10 to 16	A-6(08)	CL	100	99	99	95	80	--	22	--	37	16	104	20
C------- 27 to 60	A-6(10)	CL	100	99	98	95	82	--	29	--	34	15	114	16

TABLE 17.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Barnes	Fine-loamy, mixed Udic Haploborolls
Bearden	Fine-silty, frigid Aeric Calciaquolls
Buse	Fine-loamy, mixed Udorthentic Haploborolls
Cashel	Fine, montmorillonitic (calcareous), frigid Mollic Udifluvents
Colvin	Fine-silty, frigid Typic Calciaquolls
Divide	Fine-loamy over sandy or sandy-skeletal, frigid Aeric Calciaquolls
Dovray	Fine, montmorillonitic, frigid Cumulic Haplaquolls
Embden	Coarse-loamy, mixed Pachic Udic Haploborolls
Emrick	Coarse-loamy, mixed Pachic Udic Haploborolls
Enloe	Fine, montmorillonitic, frigid Argiaquic Argialbolls
Esmond	Coarse-loamy, mixed Udorthentic Haploborolls
Fairdale	Fine-loamy, mixed, frigid Mollic Udifluvents
Fairdale Variant	Fine-loamy over clayey, mixed calcareous, frigid Mollic Udifluvents
Fargo	Fine, montmorillonitic, frigid Vertic Haplaquolls
Galchutt	Fine, montmorillonitic, frigid Typic Argialbolls
Gardena	Coarse-silty, mixed Pachic Udic Haploborolls
Glyndon	Coarse-silty, frigid Aeric Calciaquolls
Hamerly	Fine-loamy, frigid Aeric Calciaquolls
Hegne	Fine, frigid Typic Calciaquolls
Heimdal	Coarse-loamy, mixed Udic Haploborolls
LaDelle	Fine-silty, mixed Cumulic Udic Haploborolls
Lamoure	Fine-silty, mixed (calcareous), frigid Cumulic Haplaquolls
Lindaas	Fine, montmorillonitic, frigid Typic Argiaquolls
Maddock	Sandy, mixed Udorthentic Haploborolls
Nahon	Fine, montmorillonitic Udic Natriborolls
Nutley	Fine, montmorillonitic Udertic Haploborolls
Overly	Fine-silty, mixed Pachic Udic Haploborolls
Parnell	Fine, montmorillonitic, frigid Typic Argiaquolls
Perella	Fine-silty, mixed, frigid Typic Haplaquolls
Rauville	Fine-silty, mixed (calcareous), frigid Cumulic Haplaquolls
Renshaw	Fine-loamy over sandy or sandy-skeletal, mixed Udic Haploborolls
Ryan	Fine, montmorillonitic, frigid Typic Natraquolls
Sioux	Sandy-skeletal, mixed Udorthentic Haploborolls
Svea	Fine-loamy, mixed Pachic Udic Haploborolls
Tiffany	Coarse-loamy, mixed, frigid Typic Haplaquolls
Tonka	Fine, montmorillonitic, frigid Argiaquic Argialbolls
Vallers	Fine-loamy, frigid Typic Calciaquolls
Wahpeton	Fine, montmorillonitic Udertic Haploborolls
Wyard	Fine-loamy, mixed, frigid Typic Haplaquolls
Wyndmere	Coarse-loamy, frigid Aeric Calciaquolls

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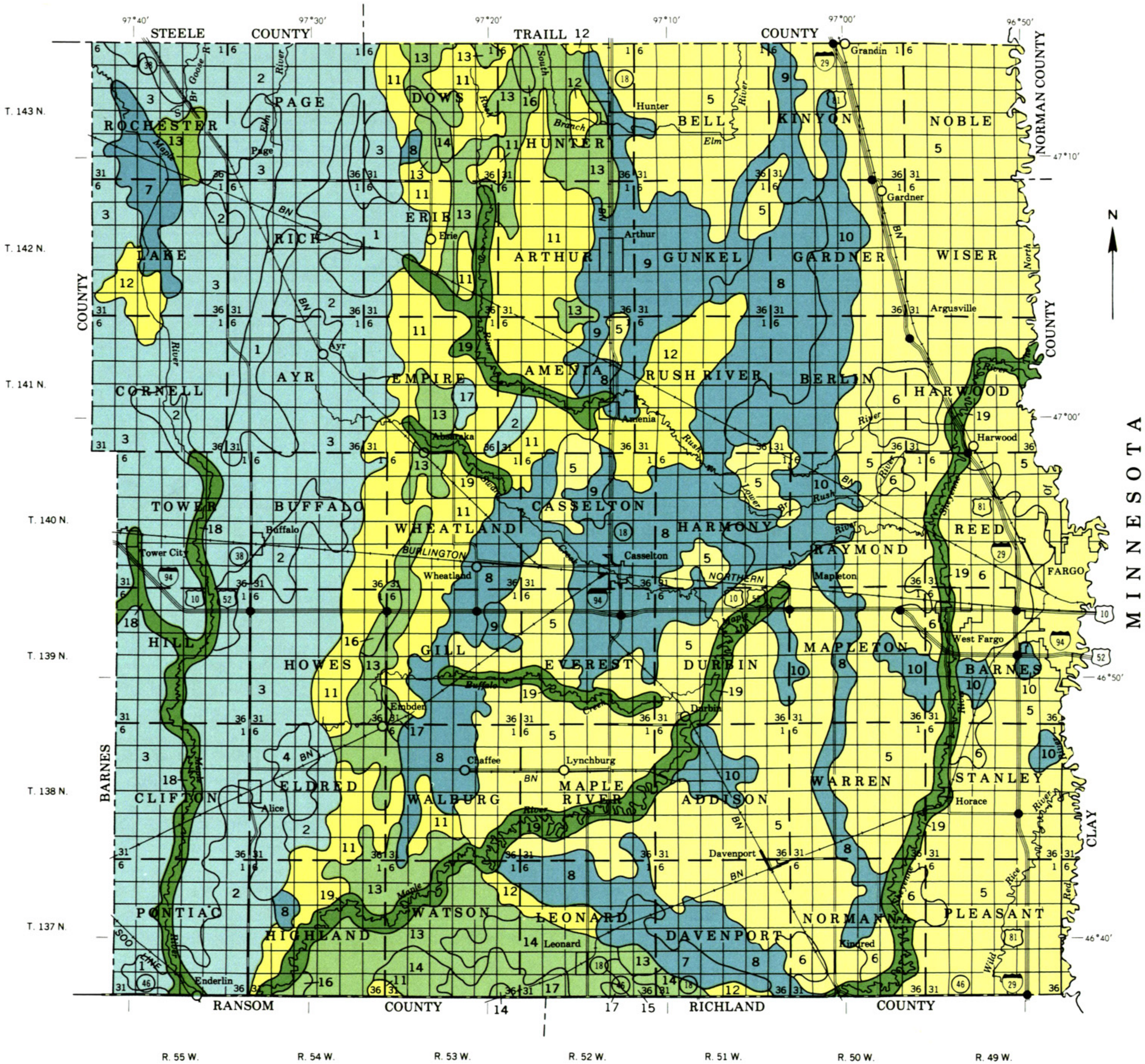


Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

LEGEND*

LEVEL TO MODERATELY STEEP, MEDIUM TEXTURED AND MODERATELY FINE TEXTURED SOILS THAT FORMED IN GLACIAL TILL AND IN ALLUVIUM OVER GLACIAL TILL; ON GLACIAL TILL PLAINS

1 Barnes-Heimdal-Emrick association: Deep, nearly level to moderately steep, well drained, medium textured soils

2 Barnes-Svea association: Deep, level to moderately steep, well drained and moderately well drained, medium textured soils

3 Hamerly-Tonka-Wyard association: Deep, level to gently sloping, somewhat poorly drained and poorly drained, medium textured soils

4 Vallers-Parnell association: Deep, level, poorly drained and very poorly drained, medium textured and moderately fine textured soils

LEVEL AND NEARLY LEVEL, FINE TEXTURED SOILS THAT FORMED IN GLACIAL LACUSTRINE SEDIMENT; ON GLACIAL LAKE PLAINS

5 Fargo-Hegne association: Deep, level and nearly level, poorly drained, fine textured soils

6 Fargo-Ryan association: Deep, level, poorly drained, fine textured soils

LEVEL TO GENTLY SLOPING, MODERATELY FINE TEXTURED AND MEDIUM TEXTURED SOILS THAT FORMED IN GLACIAL LACUSTRINE SEDIMENT AND IN MEDIUM TEXTURED MATERIAL OVER LACUSTRINE SEDIMENT: ON GLACIAL LAKE PLAINS

7 Bearden-Colvin association: Deep, level, somewhat poorly drained and poorly drained, moderately fine textured soils that have a silt loam or silty clay loam substratum

8 Bearden-Perella-Overly association: Deep, level to gently sloping, somewhat poorly drained, poorly drained, and moderately well drained, moderately fine textured soils

9 Galchutt-Fargo-Gardena association: Deep, level and nearly level, moderately well drained, somewhat poorly drained, and poorly drained, moderately fine textured and medium textured soils

10 Hegne-Bearden-Fargo association: Deep, level, somewhat poorly drained and poorly drained, moderately fine textured soils that have a silt loam, silty clay loam, or silty clay substratum

LEVEL TO GENTLY SLOPING, MEDIUM TEXTURED SOILS THAT FORMED IN GLACIAL LACUSTRINE SEDIMENT; ON GLACIAL LAKE PLAINS

11 Gardena-Glyndon association: Deep, level and nearly level, somewhat poorly drained and moderately well drained, medium textured soils

12 Glyndon-Wyndmere-Tiffany association: Deep, level to gently sloping, somewhat poorly drained and poorly drained, medium textured soils

LEVEL TO STRONGLY SLOPING, MEDIUM TEXTURED, MODERATELY COARSE TEXTURED, AND COARSE TEXTURED SOILS THAT FORMED IN GLACIAL LACUSTRINE SEDIMENT, GLACIAL OUTWASH SEDIMENT, AND ALLUVIUM; ON GLACIAL LAKE PLAINS AND ON GLACIAL OUTWASH PLAINS

13 Embden-Glyndon-Egeland association: Deep, level to gently sloping, well drained, moderately well drained, and somewhat poorly drained, moderately coarse textured and medium textured soils

14 Hecla-Hamar-Ulen association: Deep, level to gently sloping, moderately well drained, somewhat poorly drained, and poorly drained, moderately coarse textured and coarse textured soils

15 Maddock-Hamar association: Deep, level to strongly sloping, well drained, somewhat poorly drained, and poorly drained coarse textured soils

16 Renshaw-Sioux association: Deep, nearly level to strongly sloping, somewhat excessively drained and excessively drained, medium textured soils

17 Ulen-Hecla association: Deep, level and nearly level, somewhat poorly drained and moderately well drained, coarse textured and moderately coarse textured soils

LEVEL TO STEEP, MEDIUM TEXTURED AND MODERATELY FINE TEXTURED SOILS THAT FORMED IN ALLUVIUM AND IN GLACIAL TILL; ON FLOOD PLAINS AND GLACIAL TILL PLAINS

18 Barnes-Lamoure-Buse association: Deep, level to steep, well drained and poorly drained, medium textured and moderately fine textured soils

19 Fairdale-LaPrairie-LaDelle association: Deep, level and nearly level, moderately well drained, medium textured and moderately fine textured soils

*The texture terms in the descriptive headings refer to the texture of the surface layer of the major soils in each association. The general soil map includes the Cass County Area and the Tri-County Area. Detailed descriptions of the soils in the Tri-County Area are included in the Soil Survey of the Tri-County Area, published in December 1966.

Compiled 1983

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

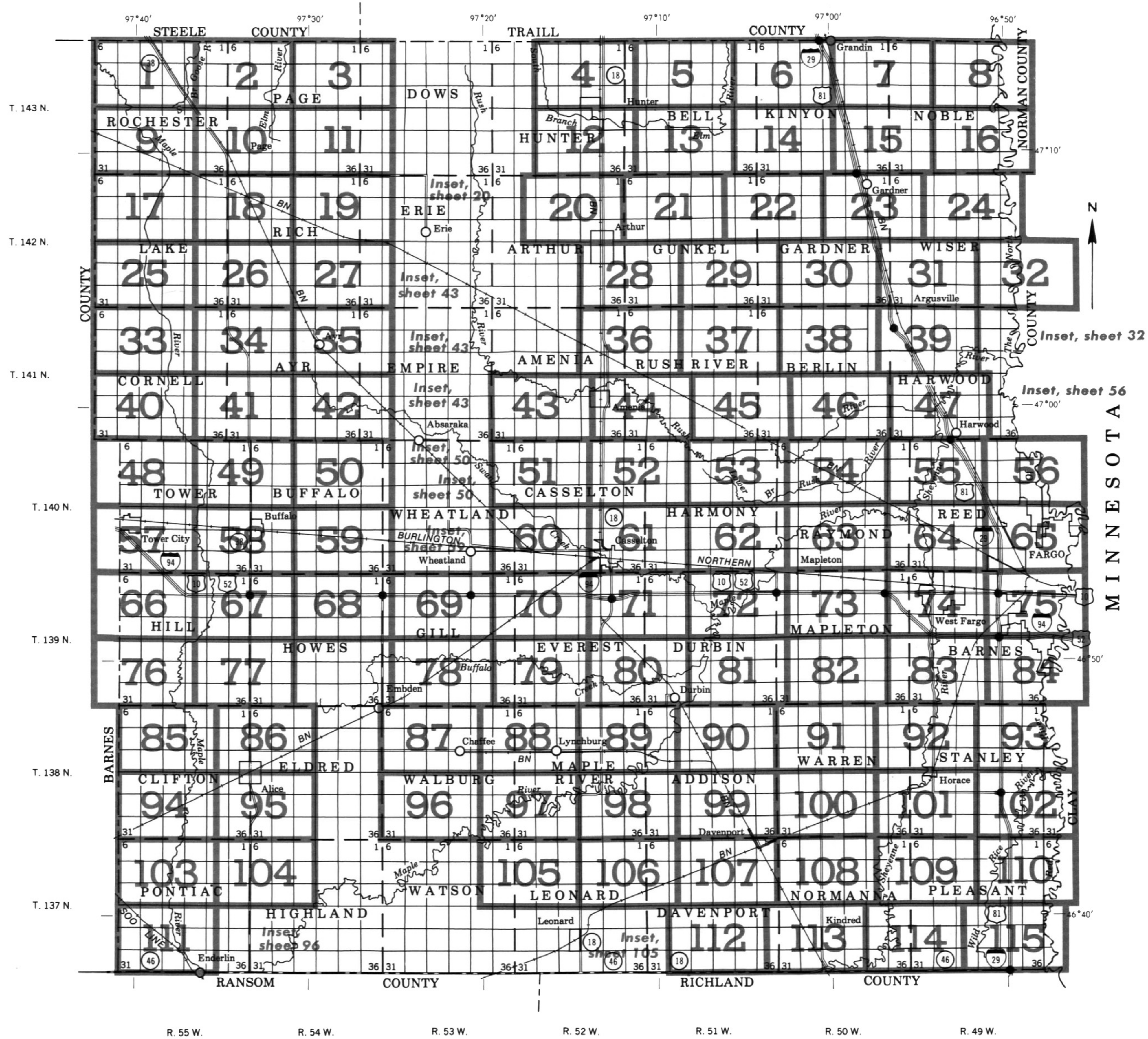
UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION
NORTH DAKOTA STATE SOIL CONSERVATION COMMITTEE

GENERAL SOIL MAP
CASS COUNTY, NORTH DAKOTA

Scale 1:316,800

1 0 1 2 3 4 5 Miles

1 0 5 10 Km



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

INDEX TO MAP SHEETS

CASS COUNTY, NORTH DAKOTA

Scale 1:316,800

1 0 1 2 3 4 5 Miles

1 0 5 10 Km

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and a letter. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas.

SYMBOL	NAME
1	Fargo-Enloe silty clays
2	Tonka silt loam
3	Parnell silty clay loam
4	Perella silty clay loam
5	Dovray silty clay
6	Parnell silty clay loam, ponded
9C	Nutley-Fargo silty clays, 1 to 9 percent slopes
10	Fargo-Ryan silty clays
11	Nahon silt loam, 0 to 2 percent slopes
12	Hegne-Enloe silty clays
14B	Barnes-Buse loams, 3 to 6 percent slopes
14C	Barnes-Buse loams, 6 to 9 percent slopes
14D	Barnes-Buse loams, 9 to 15 percent slopes
15	Emrick-Heimdal loams, 1 to 3 percent slopes
15B	Heimdal-Emrick loams, 3 to 6 percent slopes
15C	Heimdal-Esmond loams, 6 to 9 percent slopes
15D	Esmond-Heimdal loams, 9 to 15 percent slopes
16B	Barnes-Sioux loams, 3 to 6 percent slopes
16C	Barnes-Sioux loams, 6 to 9 percent slopes
16D	Barnes-Sioux loams, 9 to 15 percent slopes
17B	Barnes-Svea loams, 2 to 5 percent slopes
18	Bearden silty clay loam
19	Colvin silty clay loam, saline
20	Bearden silty clay loam, saline
22	Bearden-Perella silty clay loams
23F	Buse-Barnes loams, 15 to 35 percent slopes
24	Cashel silty clay
25	Cashel silty clay, channeled
26	Colvin silty clay loam
27	Divide loam
29	Fargo silty clay, saline
31B	Embden fine sandy loam, gravelly substratum, 1 to 6 percent slopes
32	Fargo silty clay, 1 to 3 percent slopes
35	Fairdale silty loam, 1 to 3 percent slopes
36	Fargo silty clay
37	Fargo silty clay, depressional
38	Fargo silty clay loam
39	Galchutt silt loam
40	Fargo-Hegne silty clays
41	Hegne-Fargo silty clay loams
43	Gardena silt loam
46	Gardena-Glyndon silt loams, 0 to 3 percent slopes
47	Fargo silty clay, smooth surface
48	Glyndon silt loam, 0 to 3 percent slopes
49	Glyndon silt loam, saline, 0 to 3 percent slopes
50	Hamerly-Tonka loams, 0 to 3 percent slopes
50B	Hamerly loam, 3 to 6 percent slopes
51	Hamerly loam, saline, 0 to 3 percent slopes
54	Lamoure silty clay loam
55	LaDelle silty clay loam
57	Fairdale silt loam, channeled
58B	Maddock fine sandy loam, 1 to 6 percent slopes
59	Overly silty clay loam, 0 to 3 percent slopes
59B	Overly silty clay loam, 3 to 6 percent slopes
61	Perella-Bearden silty clay loams
62	Overly-Bearden silt loams, 0 to 3 percent slopes
63B	Renshaw-Sioux loams, 1 to 6 percent slopes
63C	Sioux gravelly sandy loam, 3 to 9 percent slopes
64	Pits, gravel
65	Svea-Barnes loams, 0 to 2 percent slopes
66	Wyard-Hamerly loams, 1 to 3 percent slopes
67	Galchutt fine sandy loam
71	Vallers loam
72	Wahpeton silty clay
73	Rauville silty clay loam
76	Wyndmere silt loam, 0 to 3 percent slopes
76B	Wyndmere silt loam, undulating
77	Vallers loam, saline
78B	Svea-Buse loams, 3 to 6 percent slopes
80	Wyndmere-Tiffany loams, 0 to 3 percent slopes
82	Glyndon-Tiffany silt loams, 0 to 3 percent slopes
83	Galchutt-Fargo silty clay loams
84	Bearden-Lindaas silty clay loams
85	Fairdale Variant silt loam

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label) — Hedley Airstrip

- Small airport, airfield, park, oilfield, cemetery, or flood pool — FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate — 21
- Federal — 173
- State — 28
- County, farm or ranch — 1283

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small — water, w

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — Gas
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water, w
- Intermittent — int, i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — 66, 15B

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

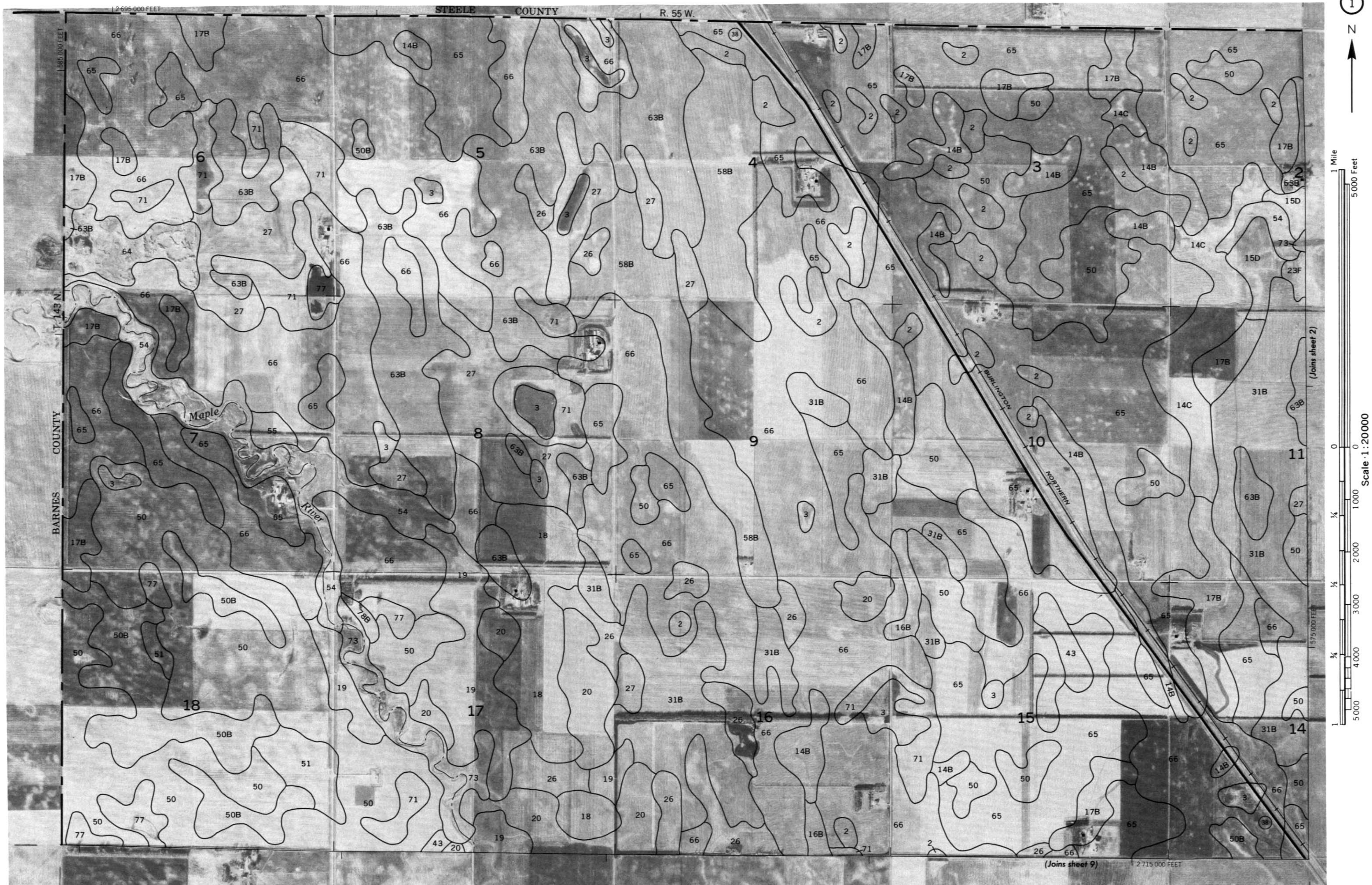
GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown) — S

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Tonka soil spot (up to 3 acres)
- Borrow land (up to 10 acres)
- Parnell soil spot (up to 3 acres)



CASS COUNTY AREA, NORTH DAKOTA NO. 1
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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA — SHEET NUMBER 2

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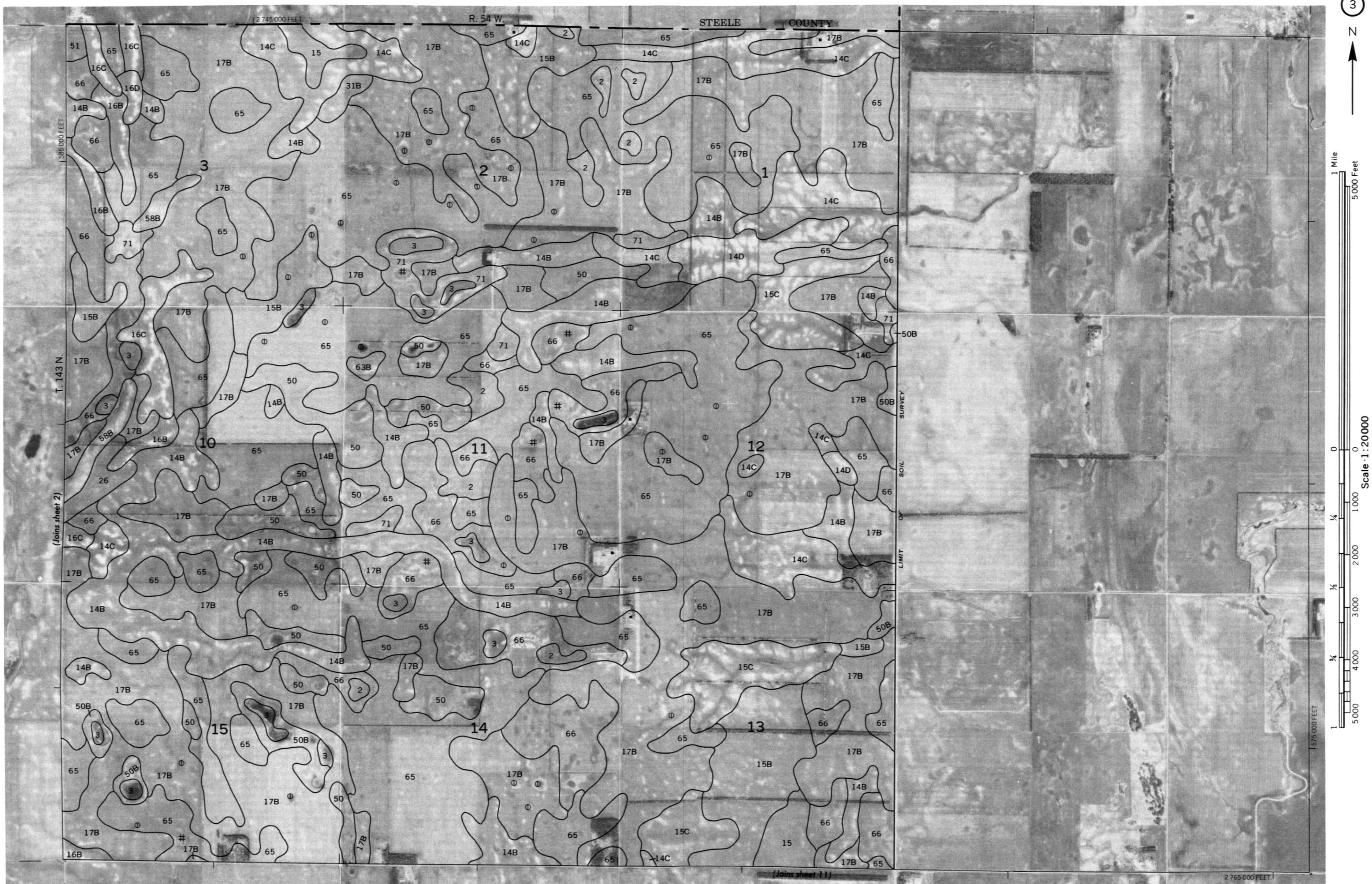
CASS COUNTY AREA, NORTH DAKOTA NO. 2



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CASS COUNTY AREA, NORTH DAKOTA NO. 4

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CASS COUNTY AREA, NORTH DAKOTA — SHEET NUMBER 6

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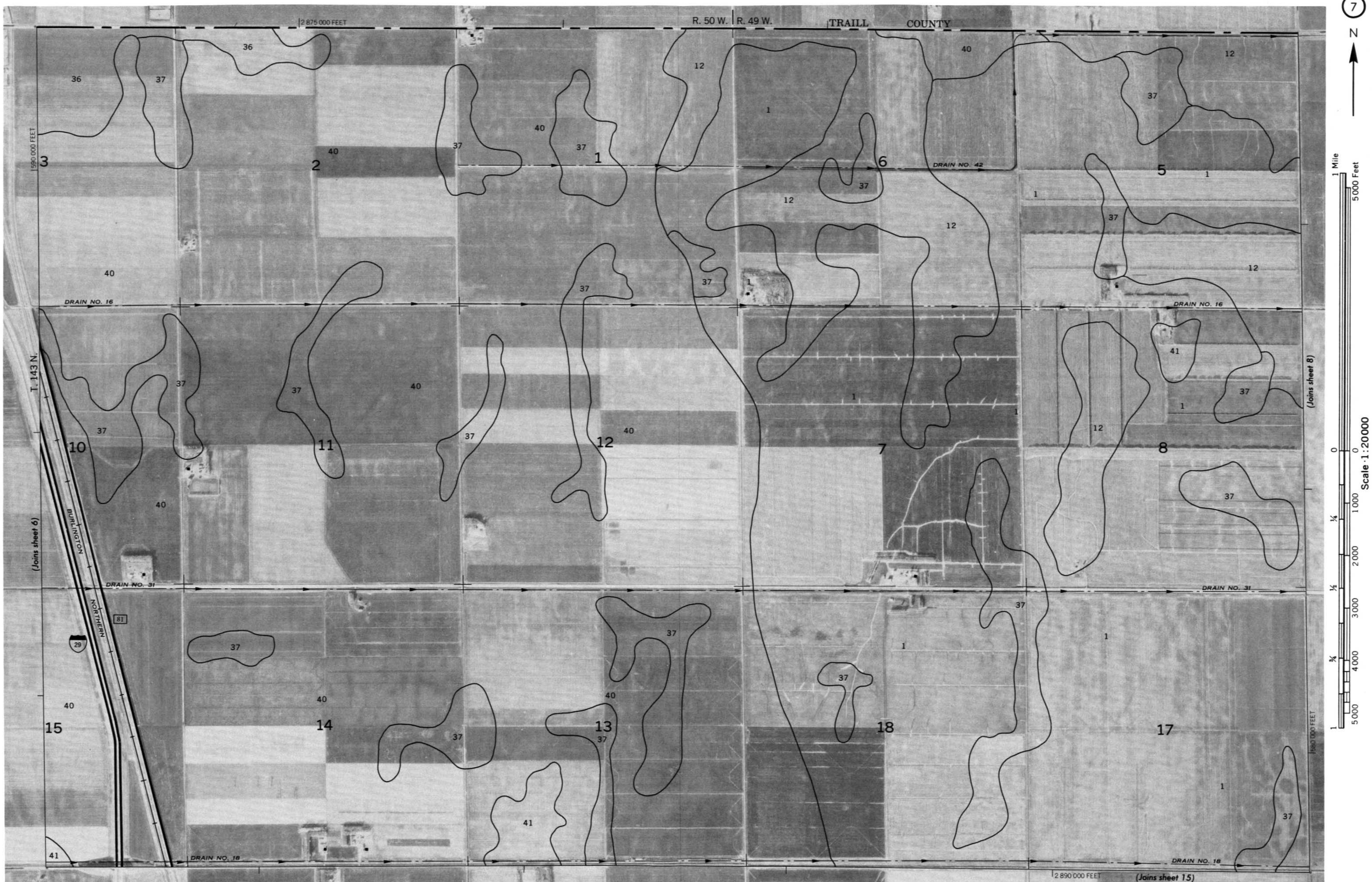

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CASS COUNTY AREA, NORTH DAKOTA — SHEET NUMBER 8

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CASS COUNTY AREA, NORTH DAKOTA NO. 8

CASS COUNTY AREA, NORTH DAKOTA NO. 9

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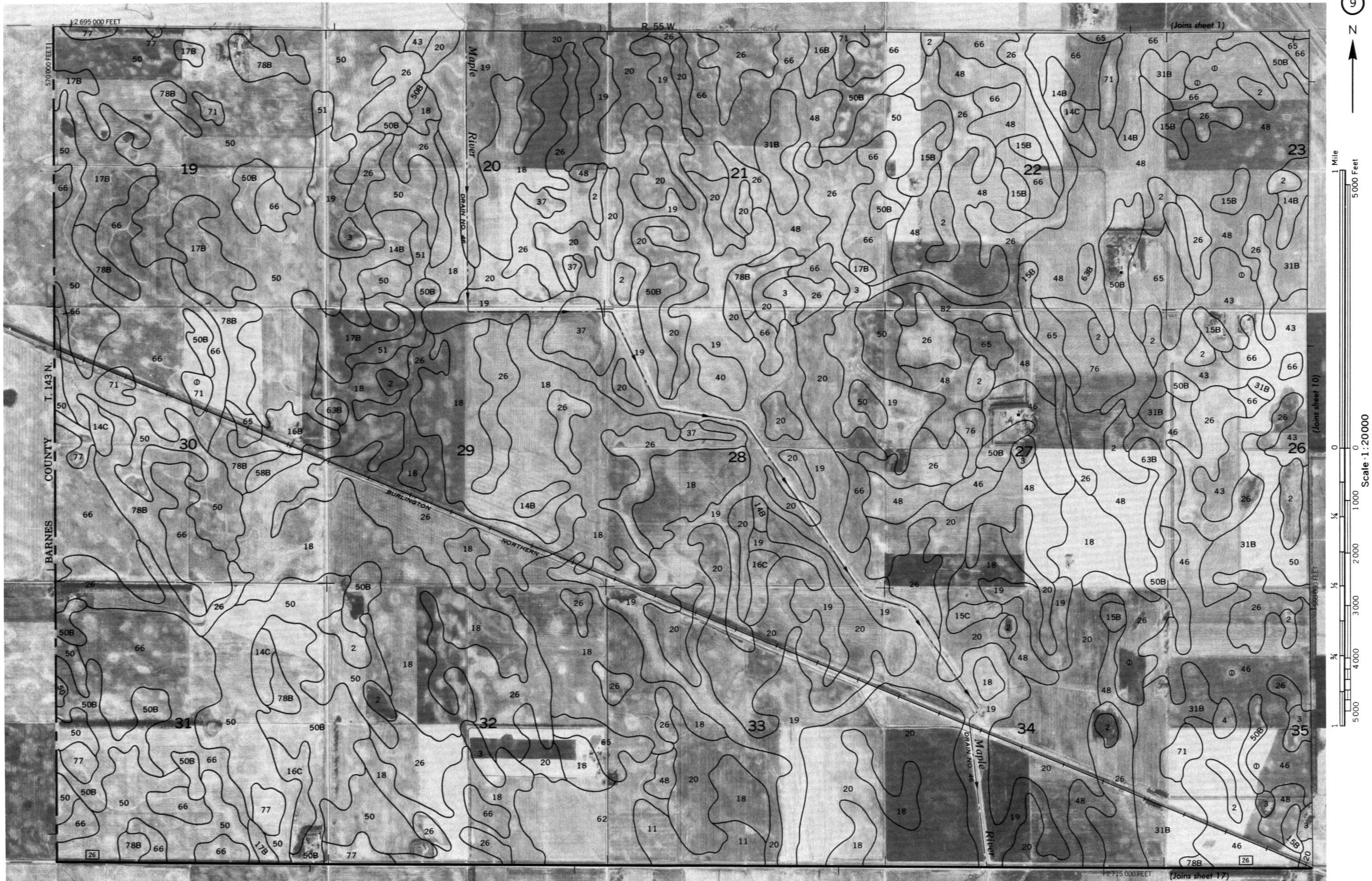

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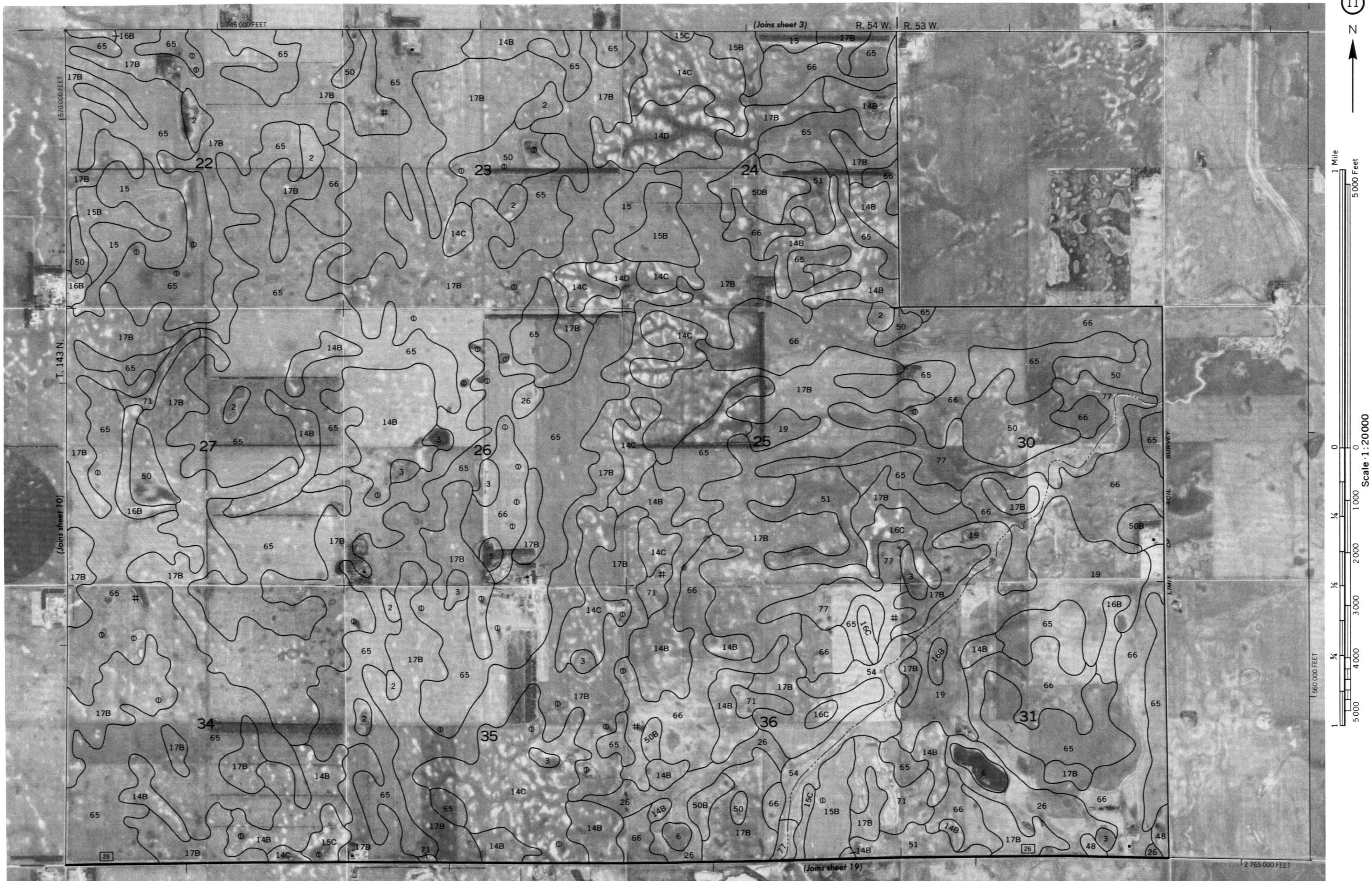

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CASS COUNTY AREA, NORTH DAKOTA — SHEET NUMBER 12

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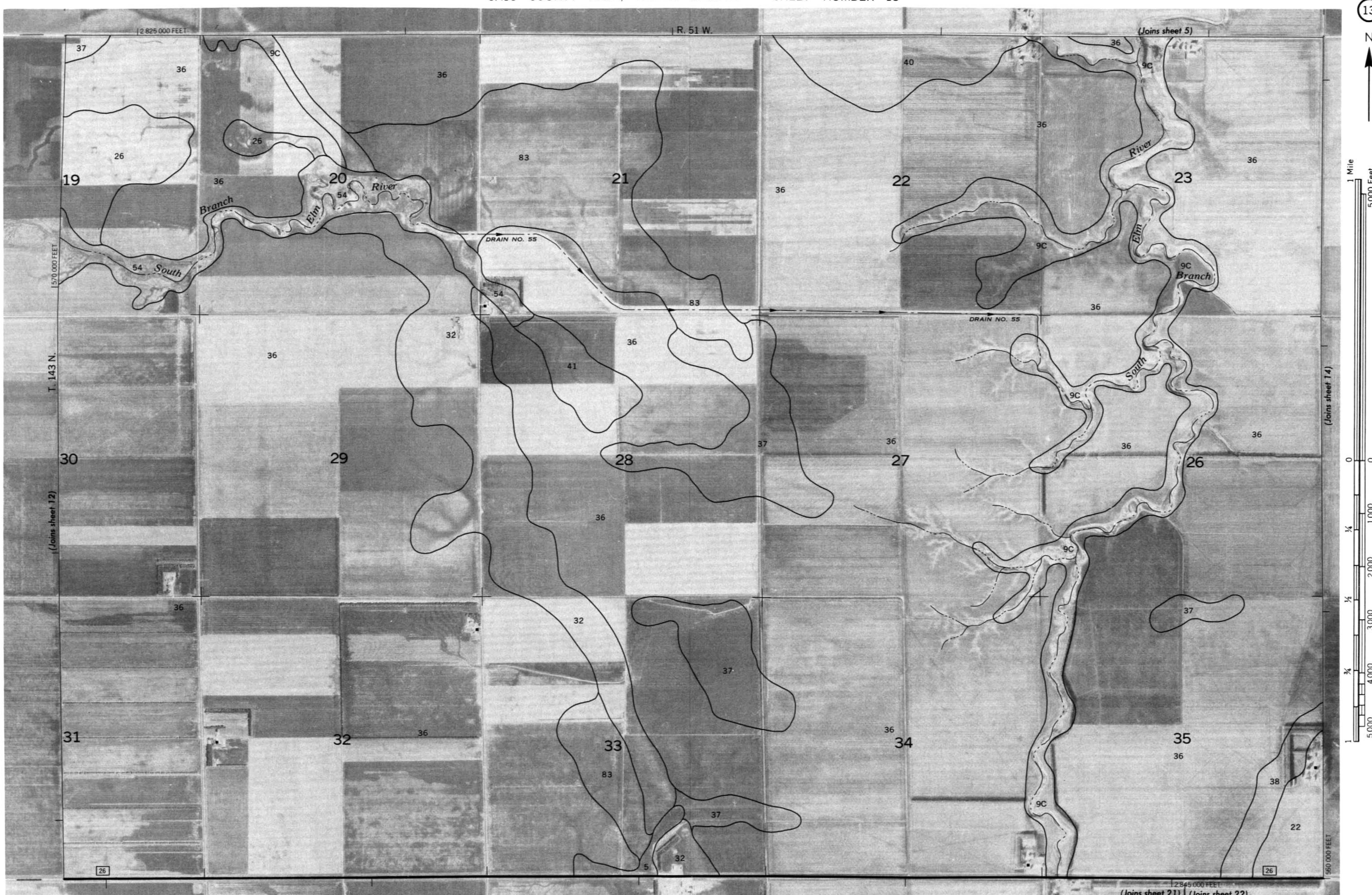
CASS COUNTY AREA, NORTH DAKOTA NO. 12



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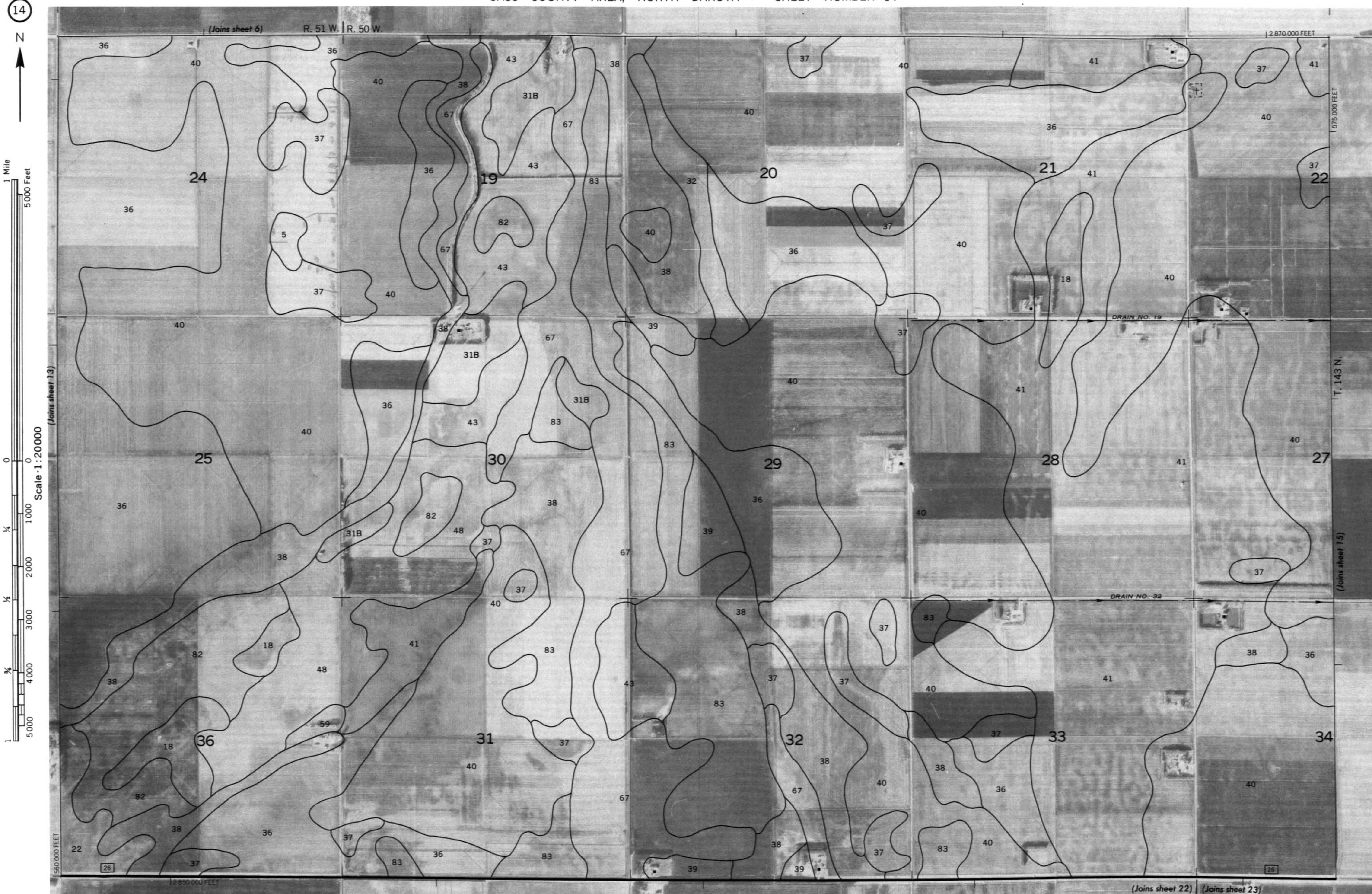

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CASS COUNTY AREA, NORTH DAKOTA NO. 14

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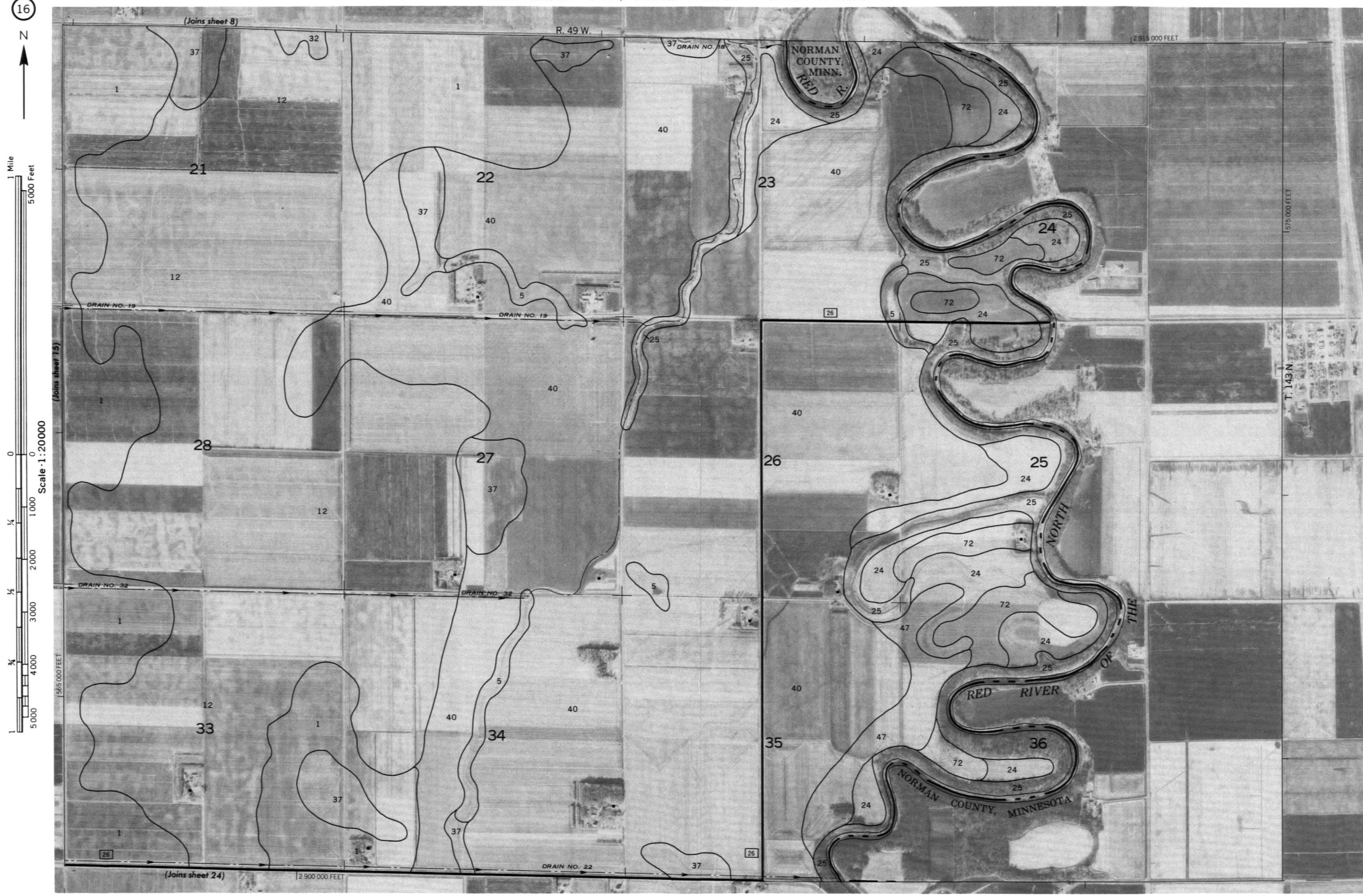
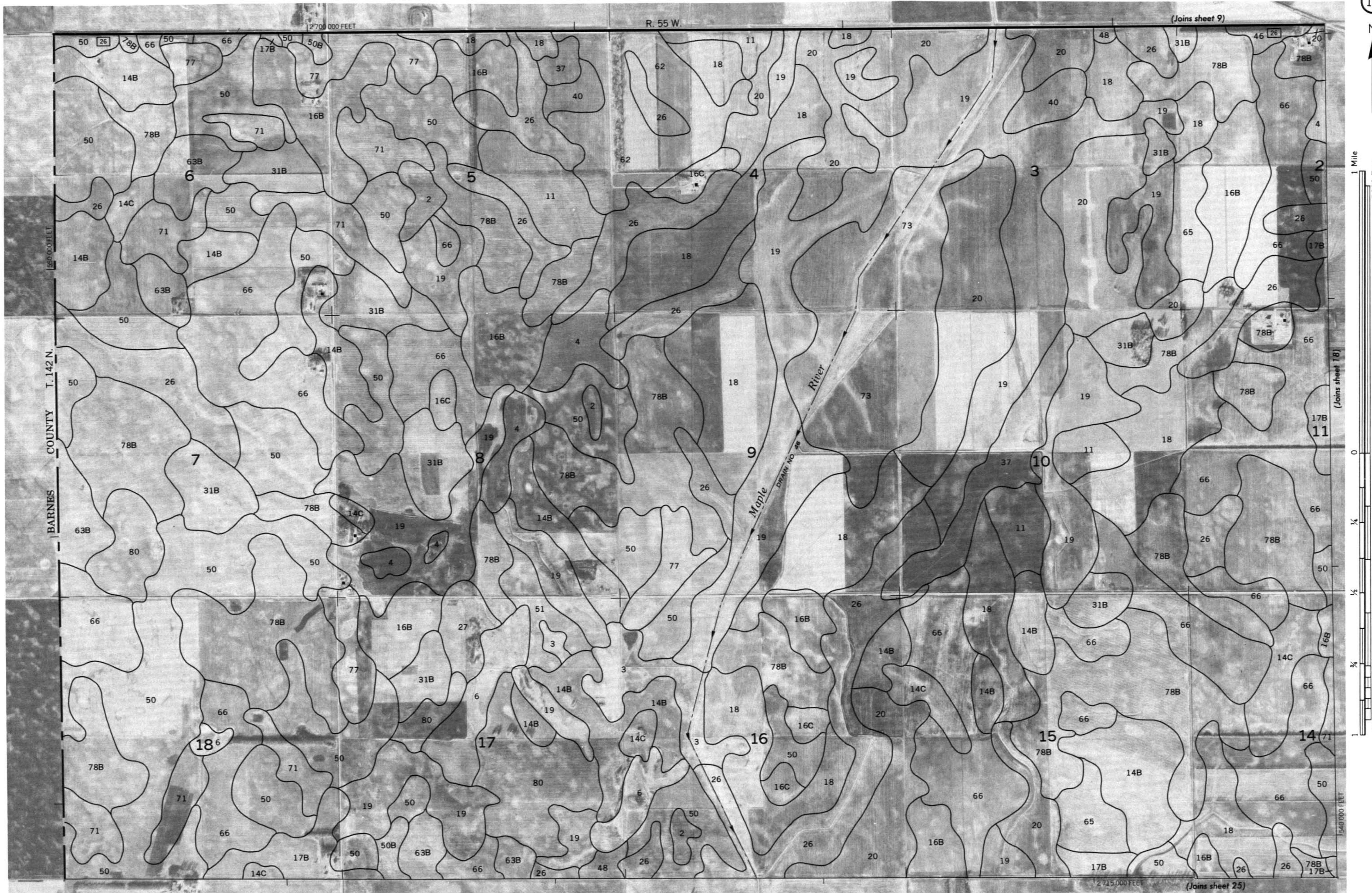

16
N
(Joins sheet 8)
R. 49 W.
2 915 000 FEET
NORMAN COUNTY, MINN.
RED R.
DRAIN NO. 18
DRAIN NO. 19
DRAIN NO. 32
DRAIN NO. 22
(Joins sheet 15)
(Joins sheet 24)
2 900 000 FEET
575 000 FEET
565 000 FEET
T. 143 N.
21
22
23
24
25
26
27
28
33
34
35
36
NORTH OF THE RED RIVER
NORMAN COUNTY, MINNESOTA
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1



CASS COUNTY AREA, NORTH DAKOTA NO. 17

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18

N

1 Mile
5000 Feet
Scale 1:20000

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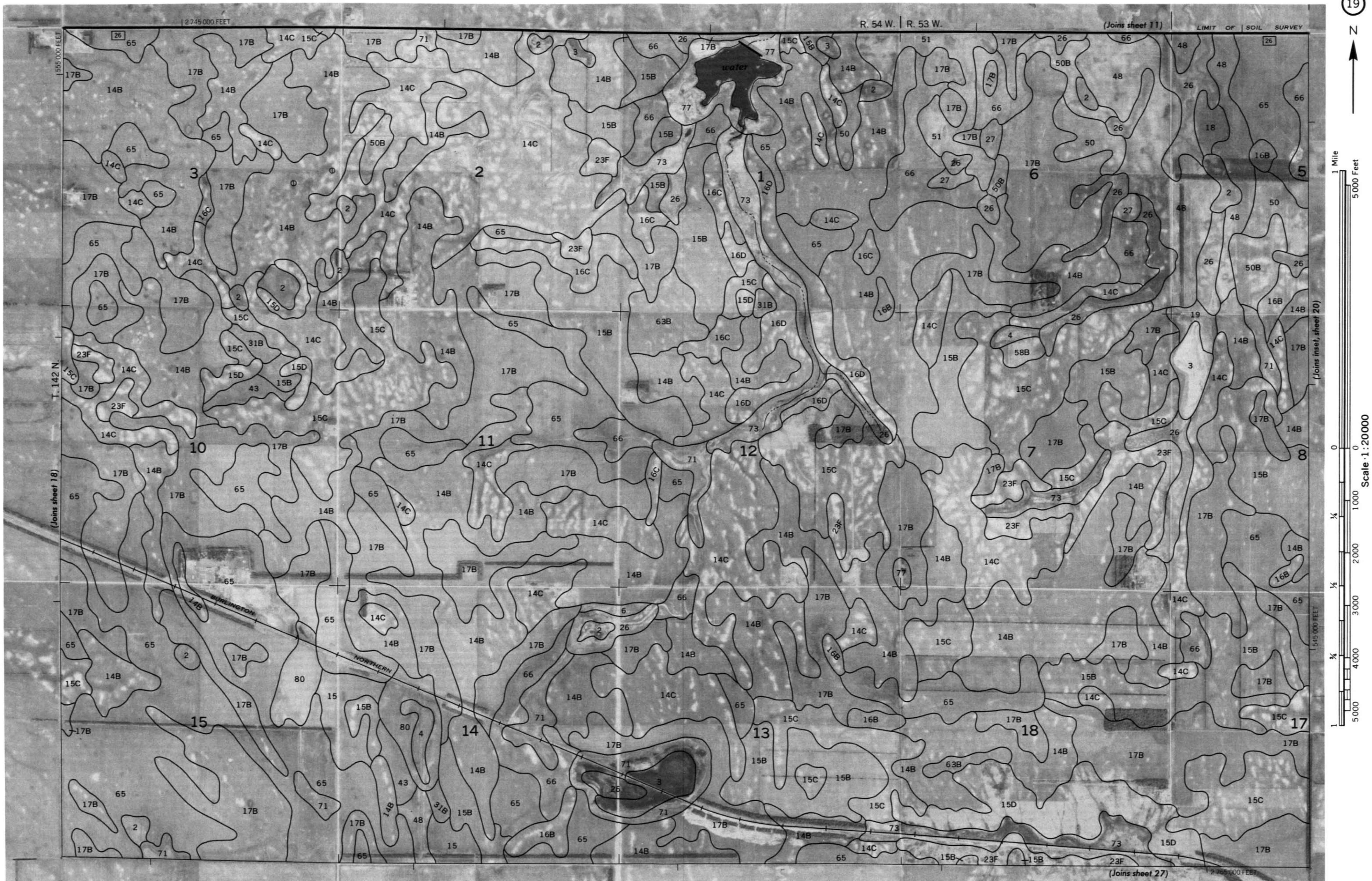

CASS COUNTY AREA, NORTH DAKOTA NO. 19

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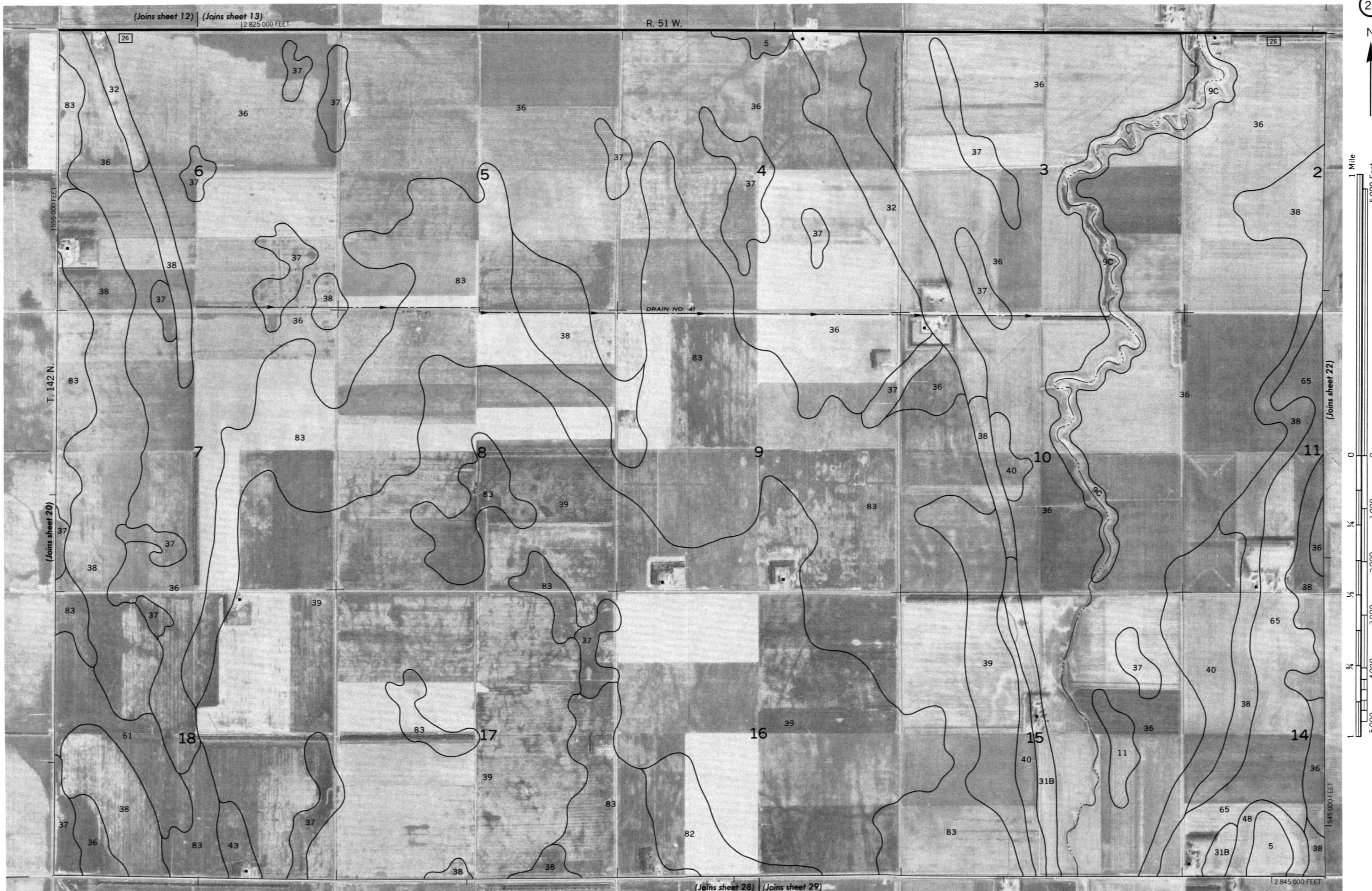
CASS COUNTY AREA, NORTH DAKOTA NO. 20



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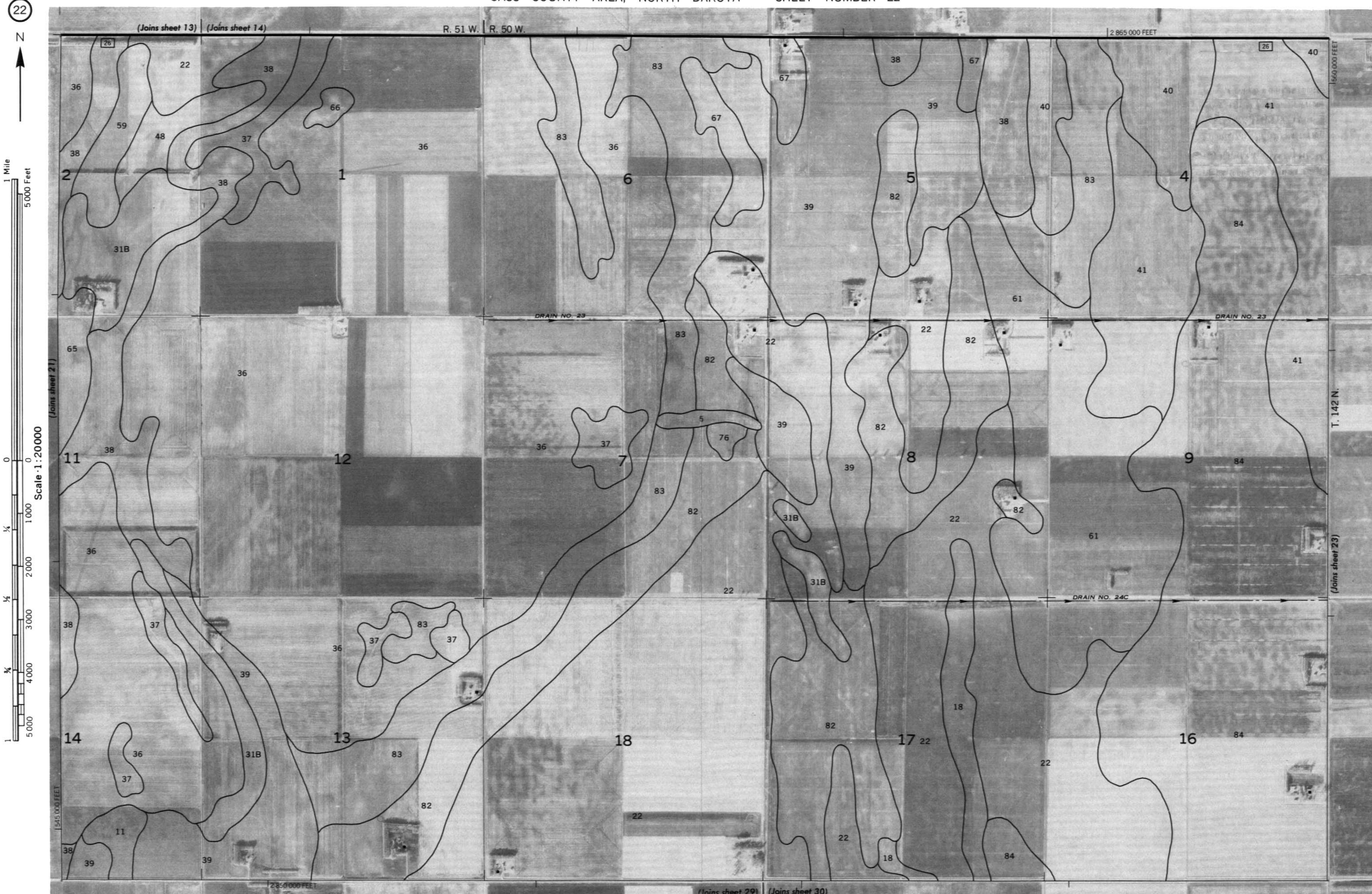

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CASS COUNTY AREA, NORTH DAKOTA NO. 23

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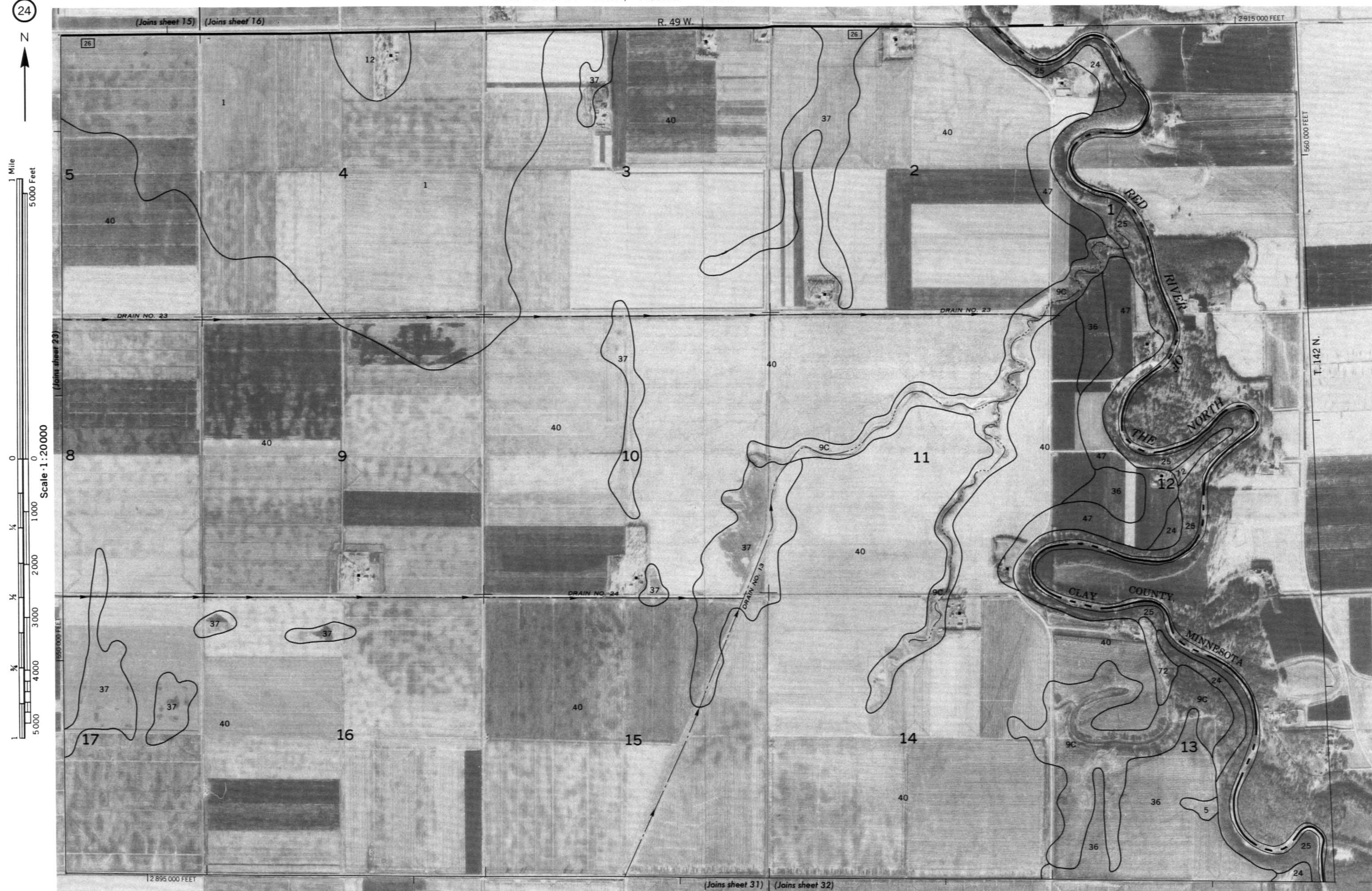

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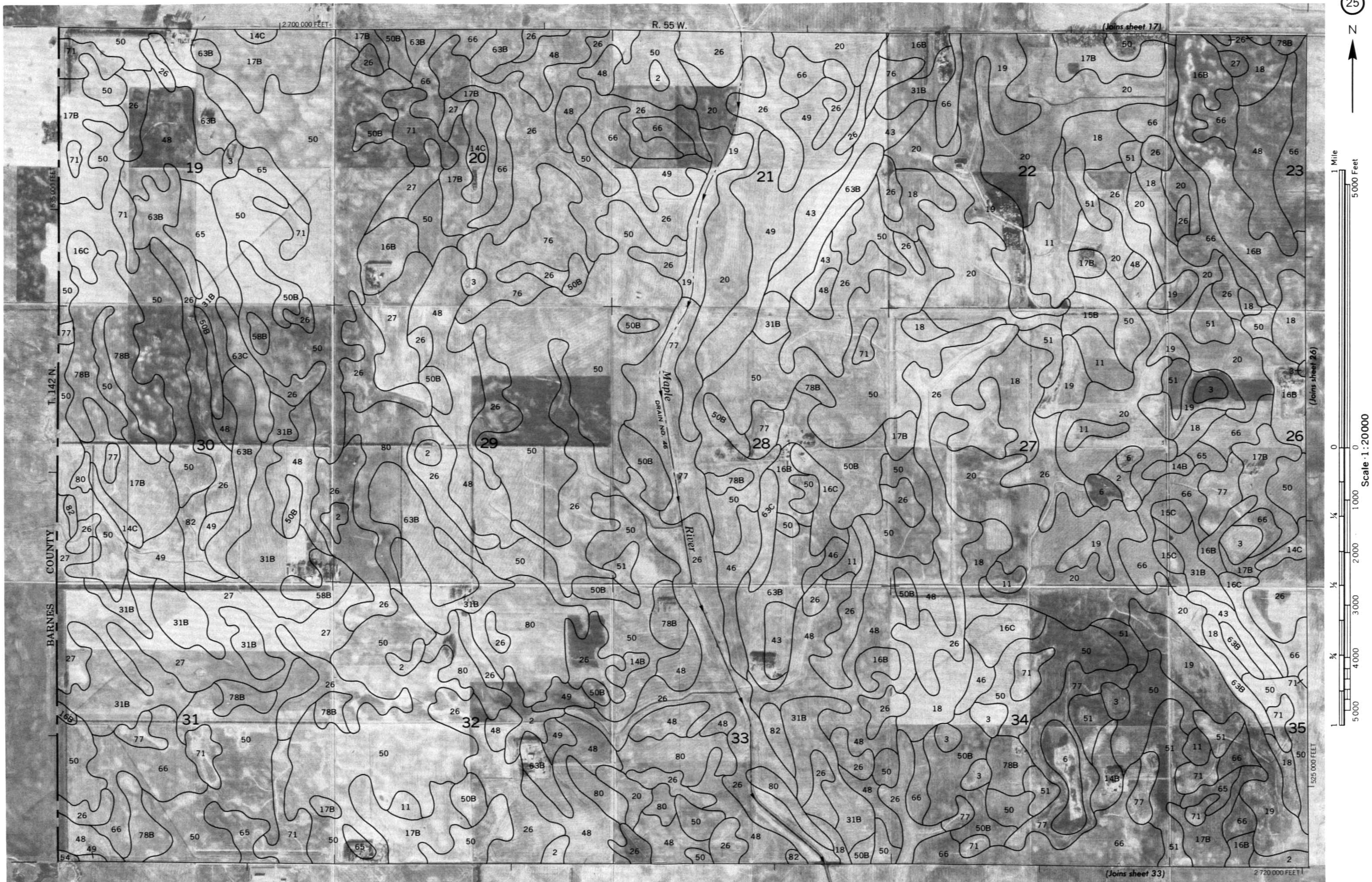
CASS COUNTY AREA, NORTH DAKOTA NO. 24



CASS COUNTY AREA, NORTH DAKOTA NO. 25
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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

26

N

1 Mile
5000 Feet

Scale 1:20000

0 ¼ ½ ¾ 1

0 1000 2000 3000 4000 5000

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CASS COUNTY AREA, NORTH DAKOTA NO. 27
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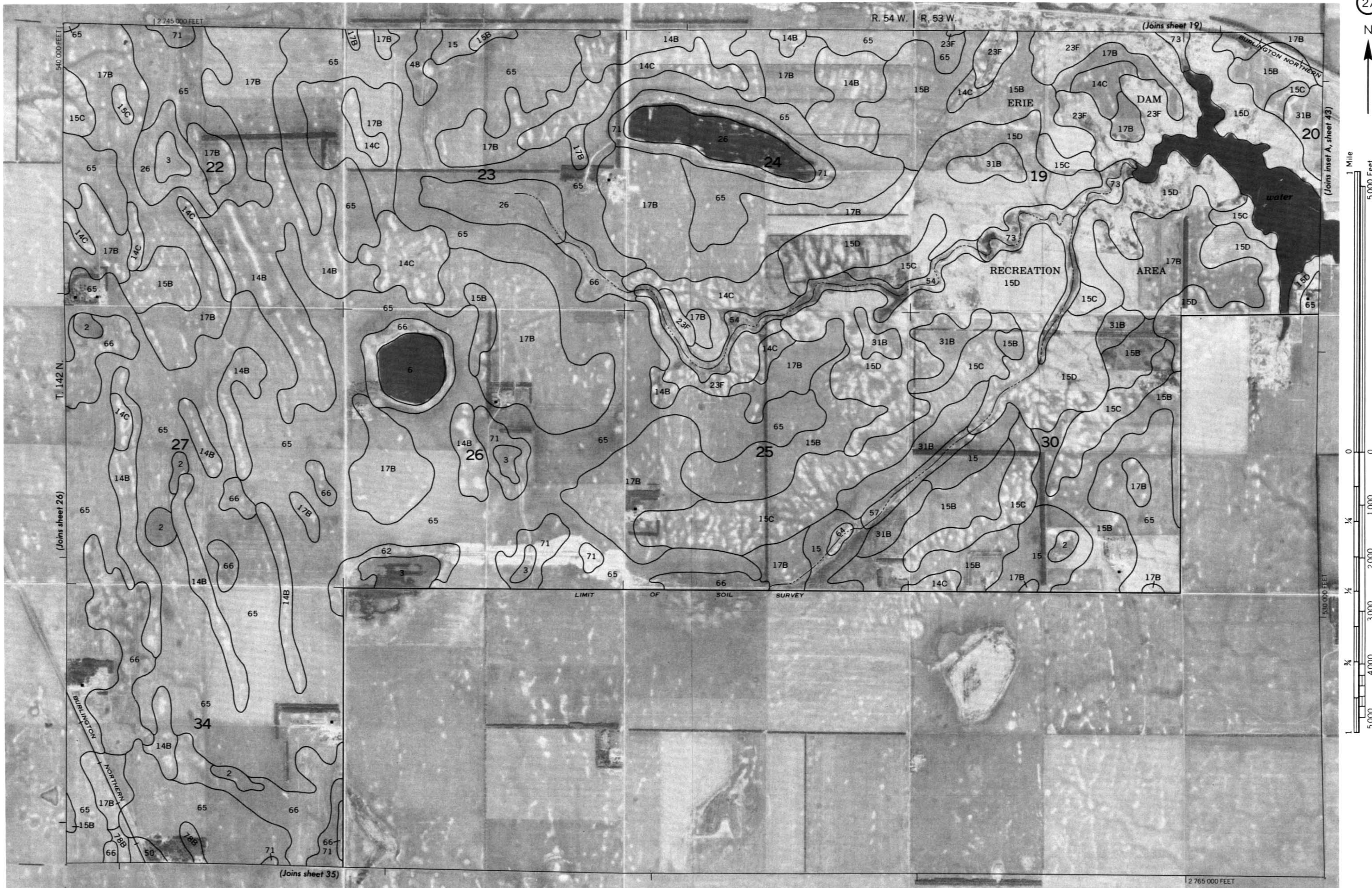

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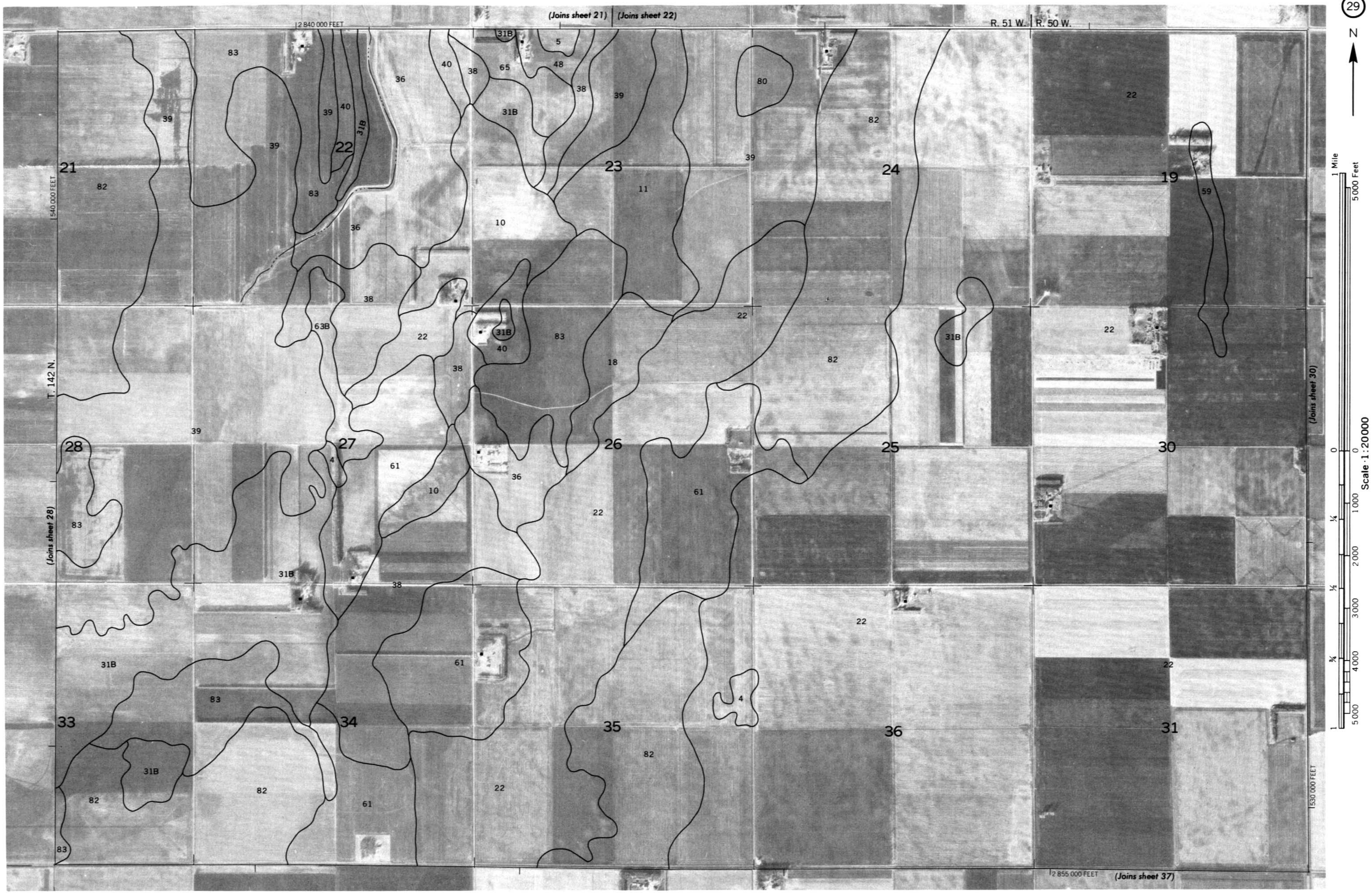
CASS COUNTY AREA, NORTH DAKOTA NO. 28



CASS COUNTY AREA, NORTH DAKOTA NO. 29

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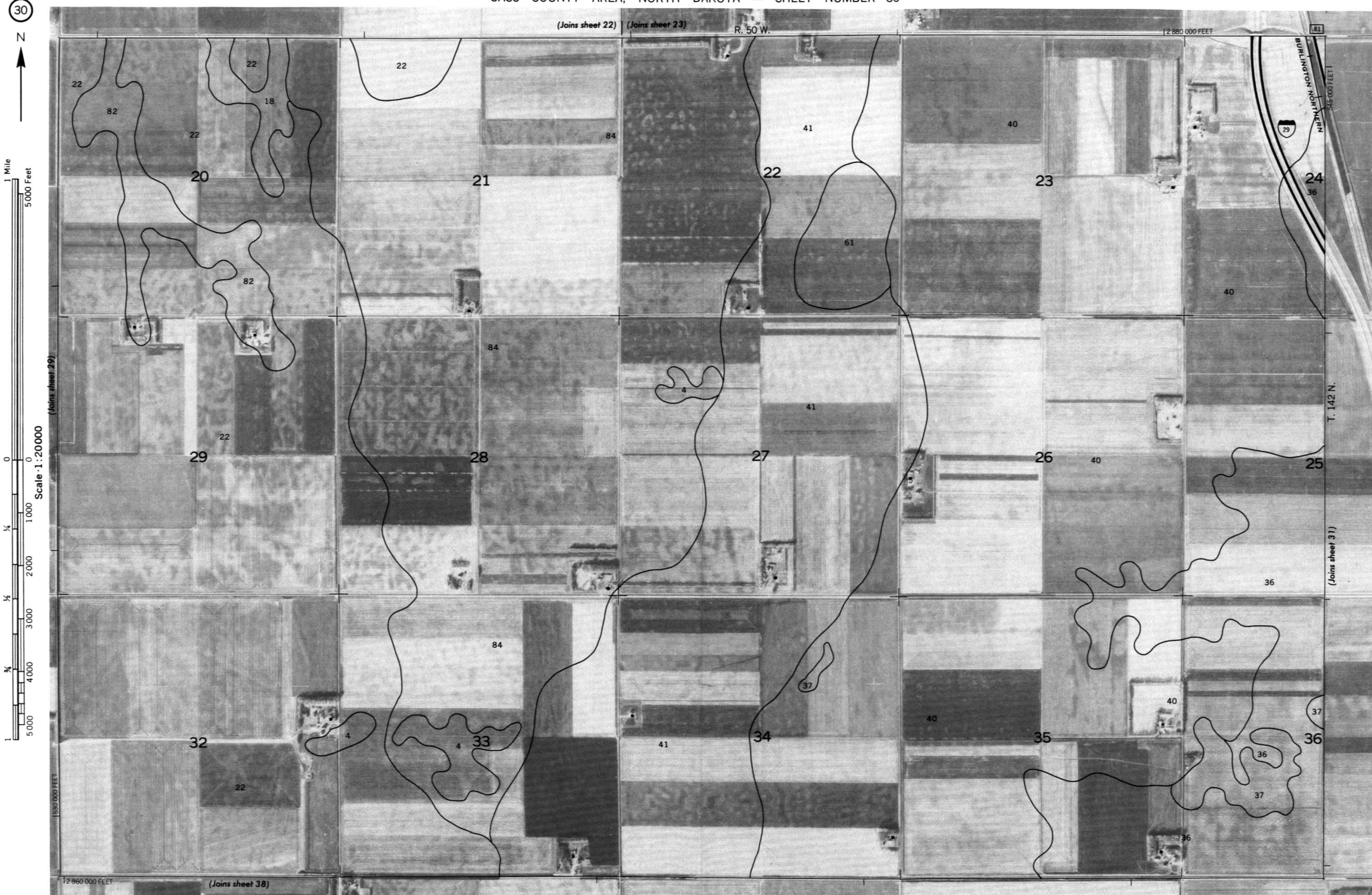

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CASS COUNTY AREA, NORTH DAKOTA NO. 30

CASS COUNTY AREA, NORTH DAKOTA NO. 31

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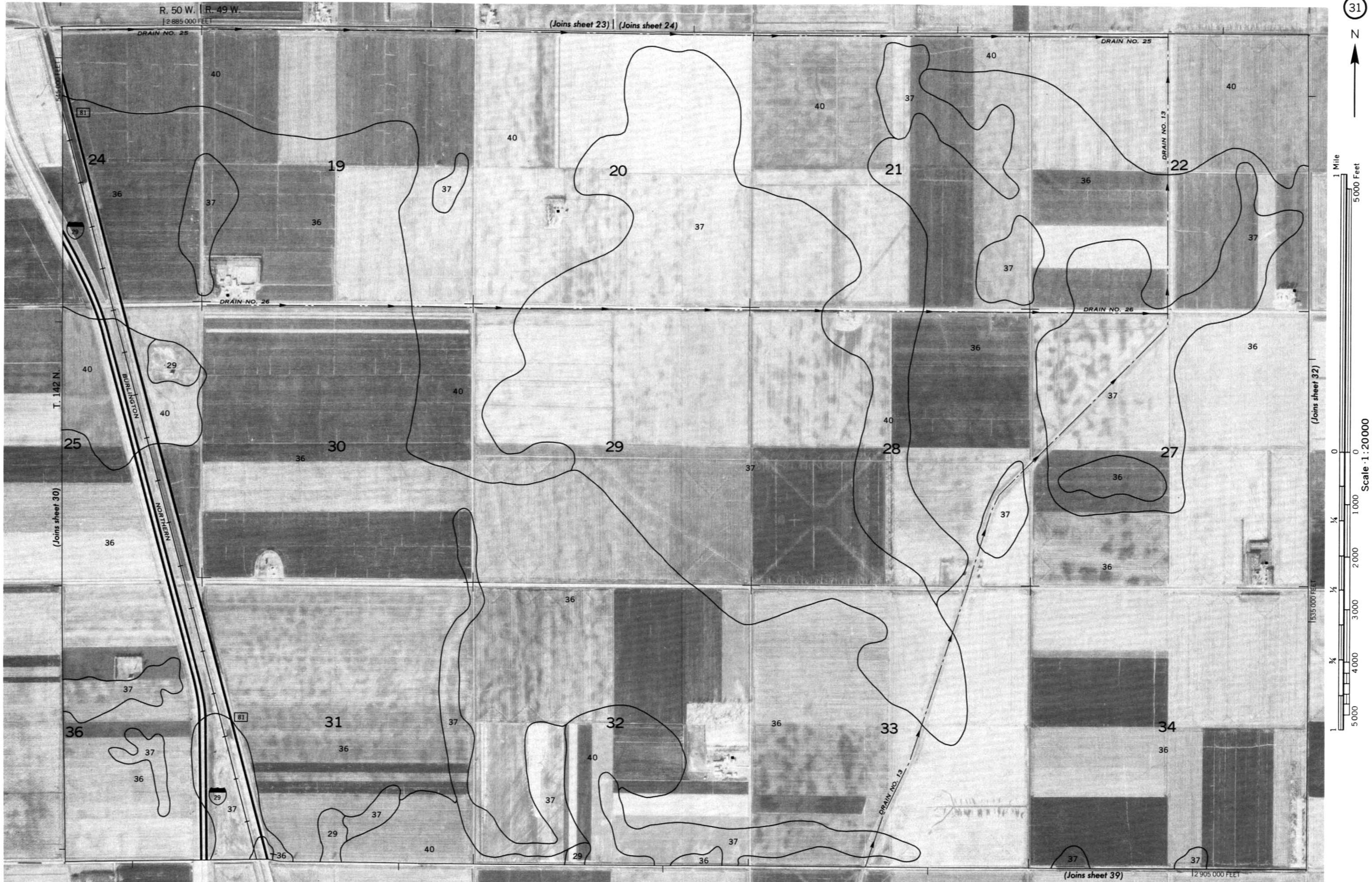

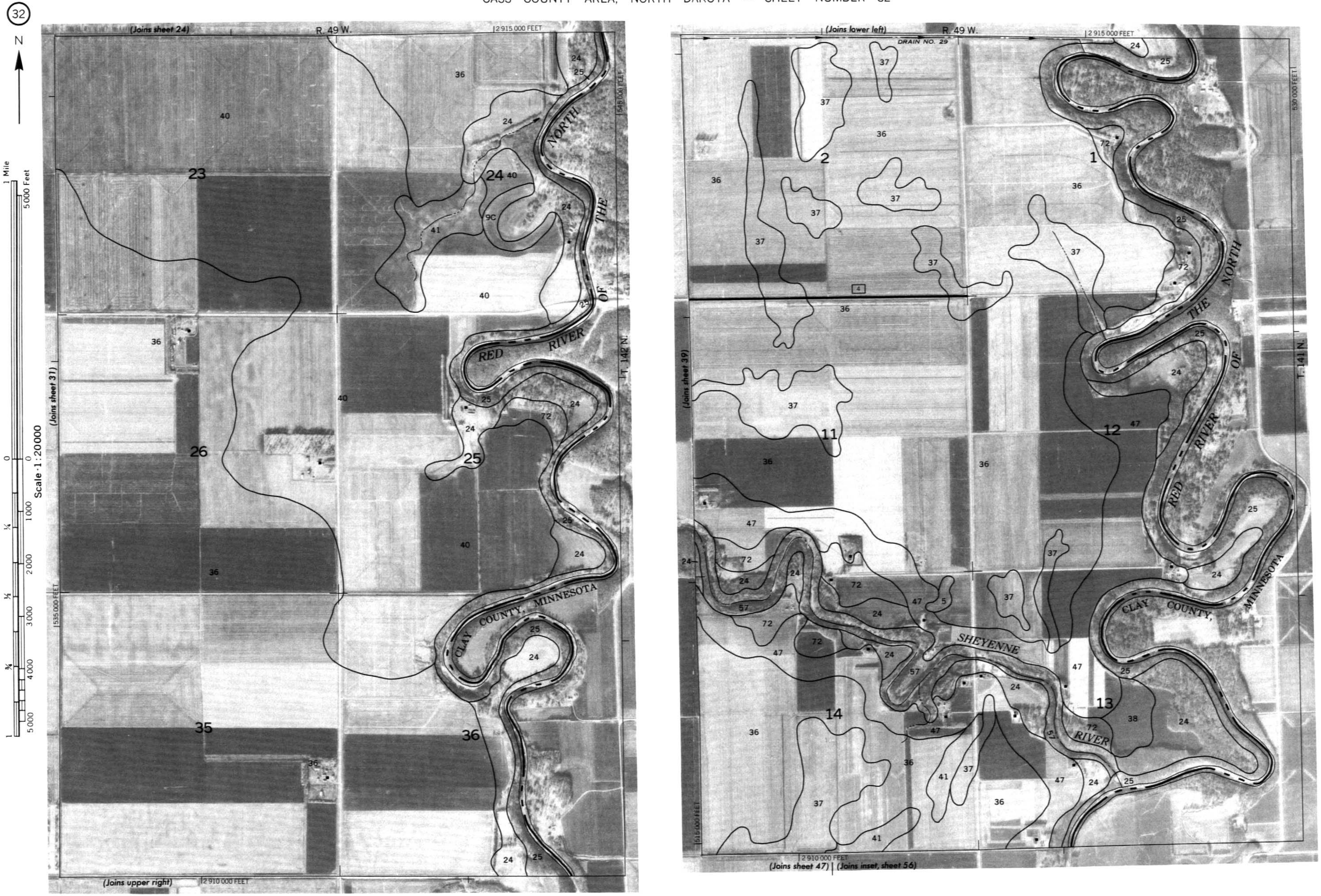

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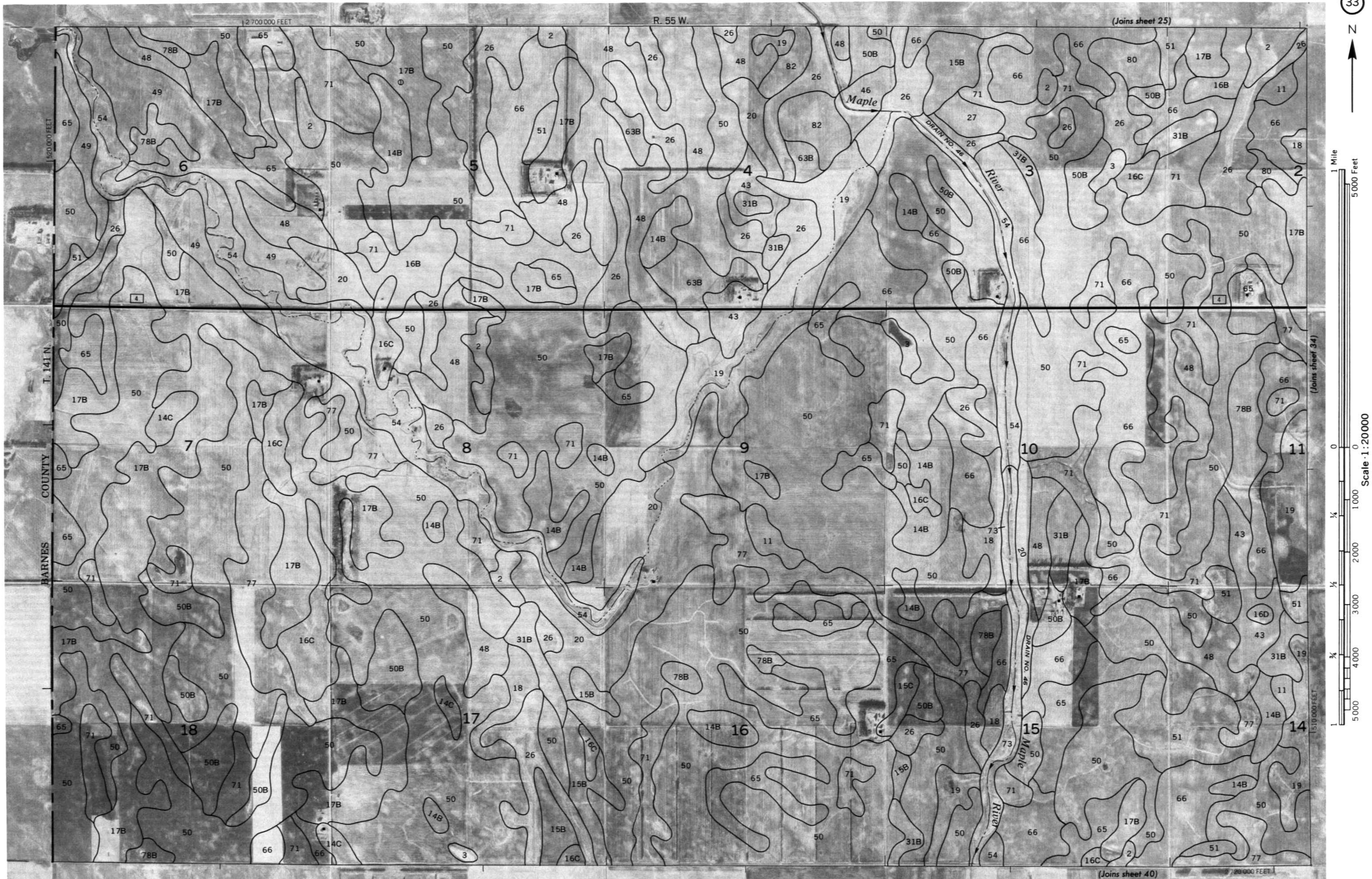
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA NO. 32



CASS COUNTY AREA, NORTH DAKOTA NO. 33

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

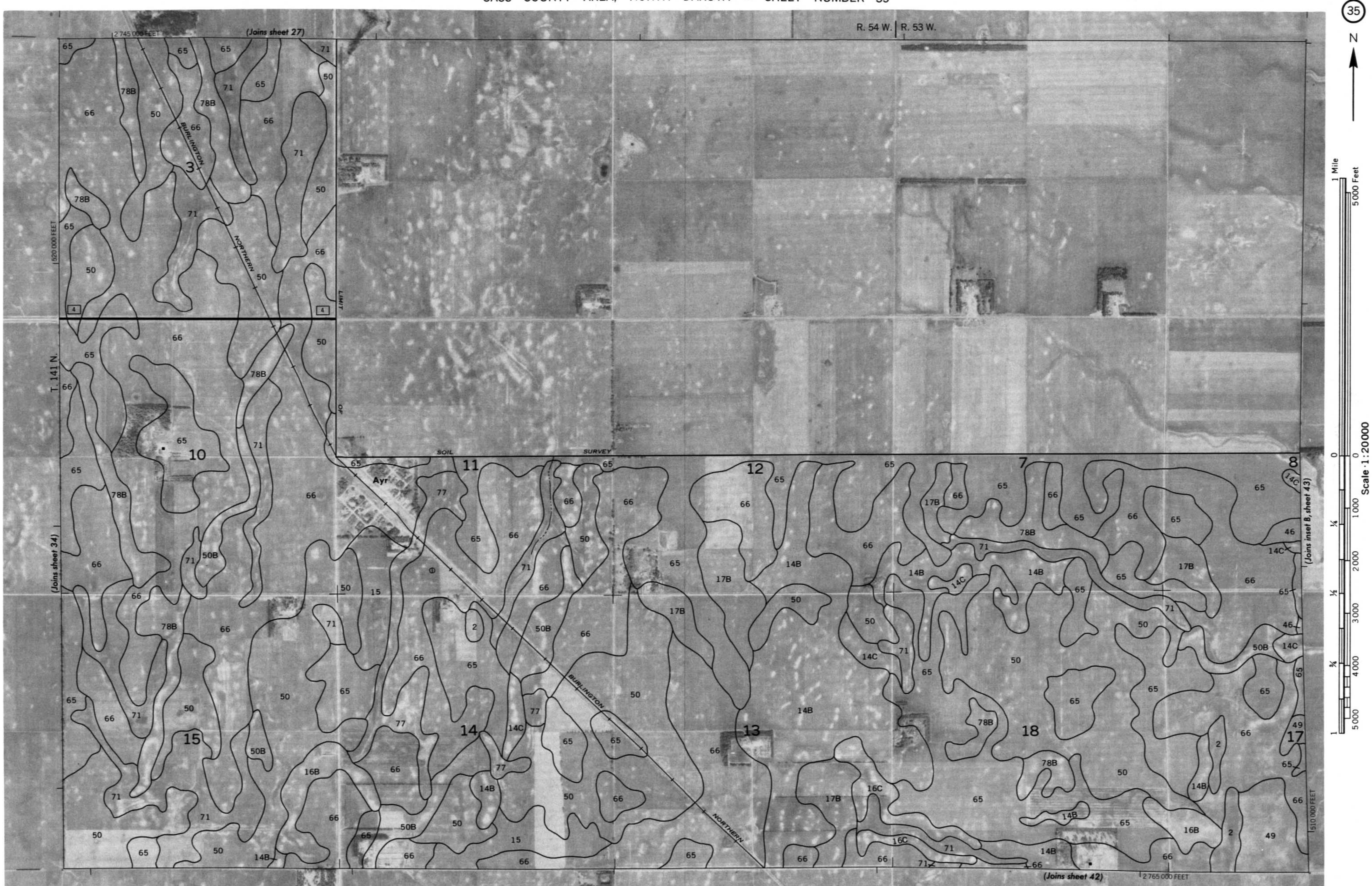
CASS COUNTY AREA, NORTH DAKOTA — SHEET NUMBER 34

N

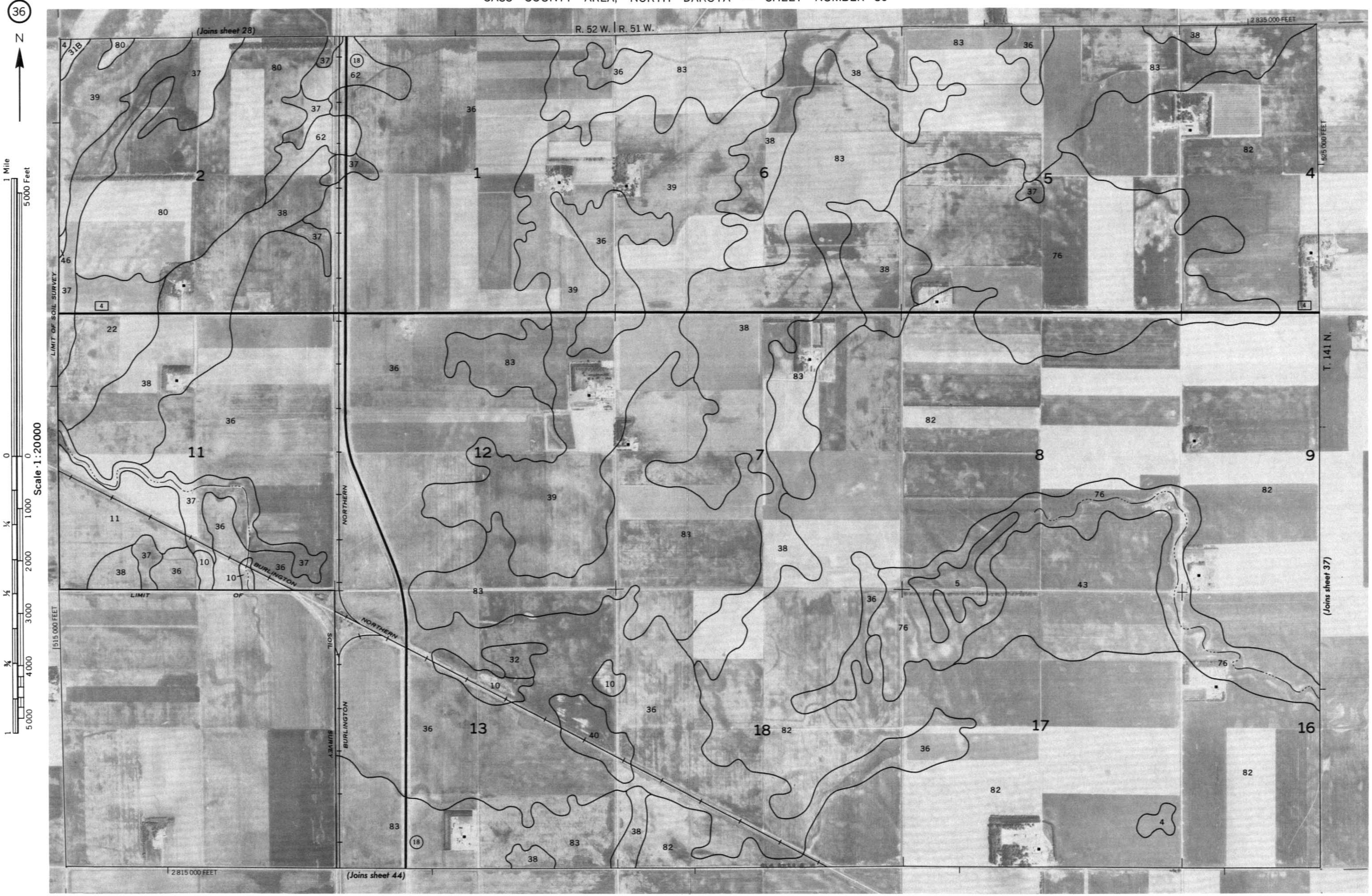
Scale 1:20000

1 Mile — 5000 Feet

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



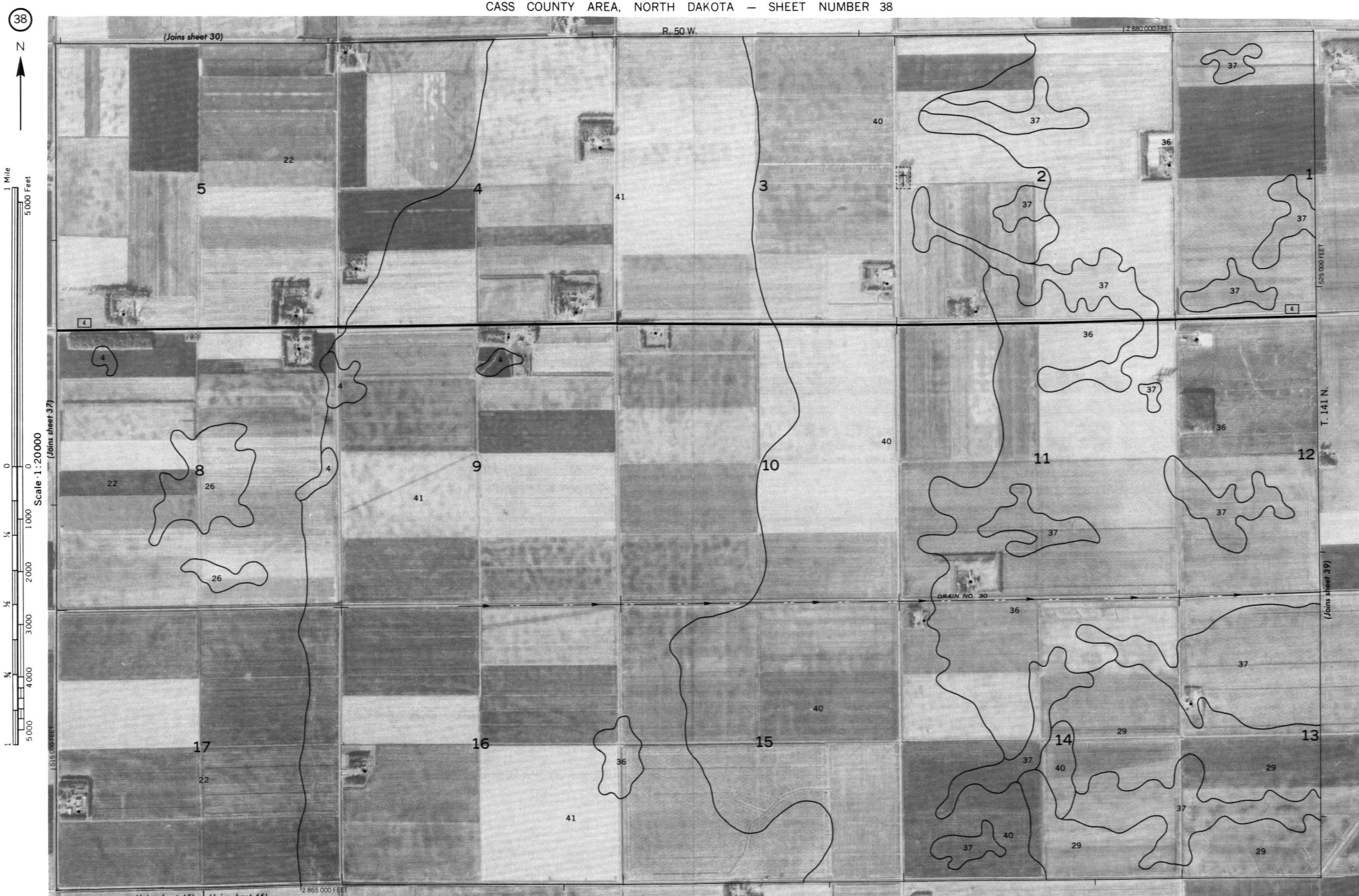
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



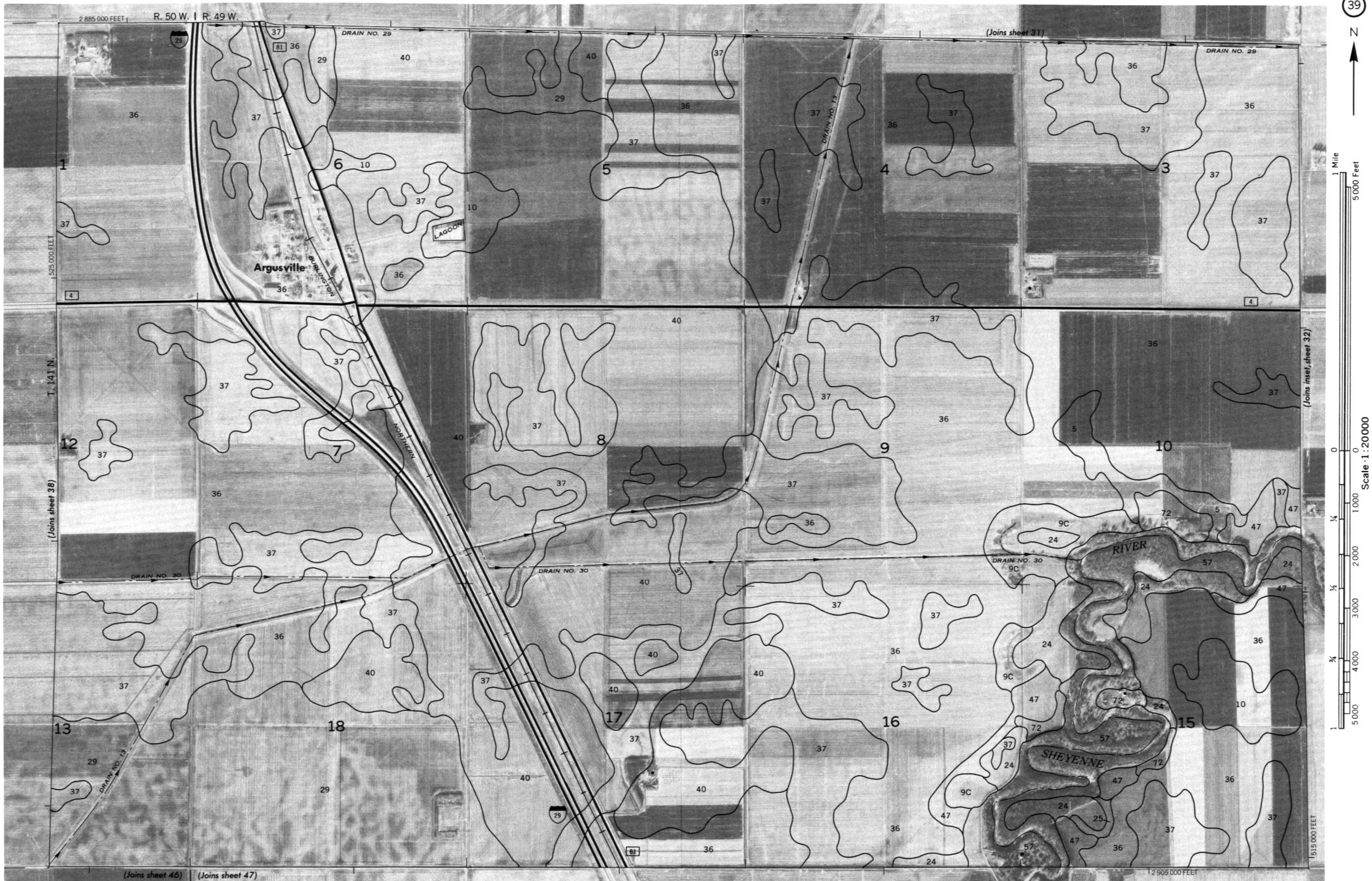
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA NO. 37

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

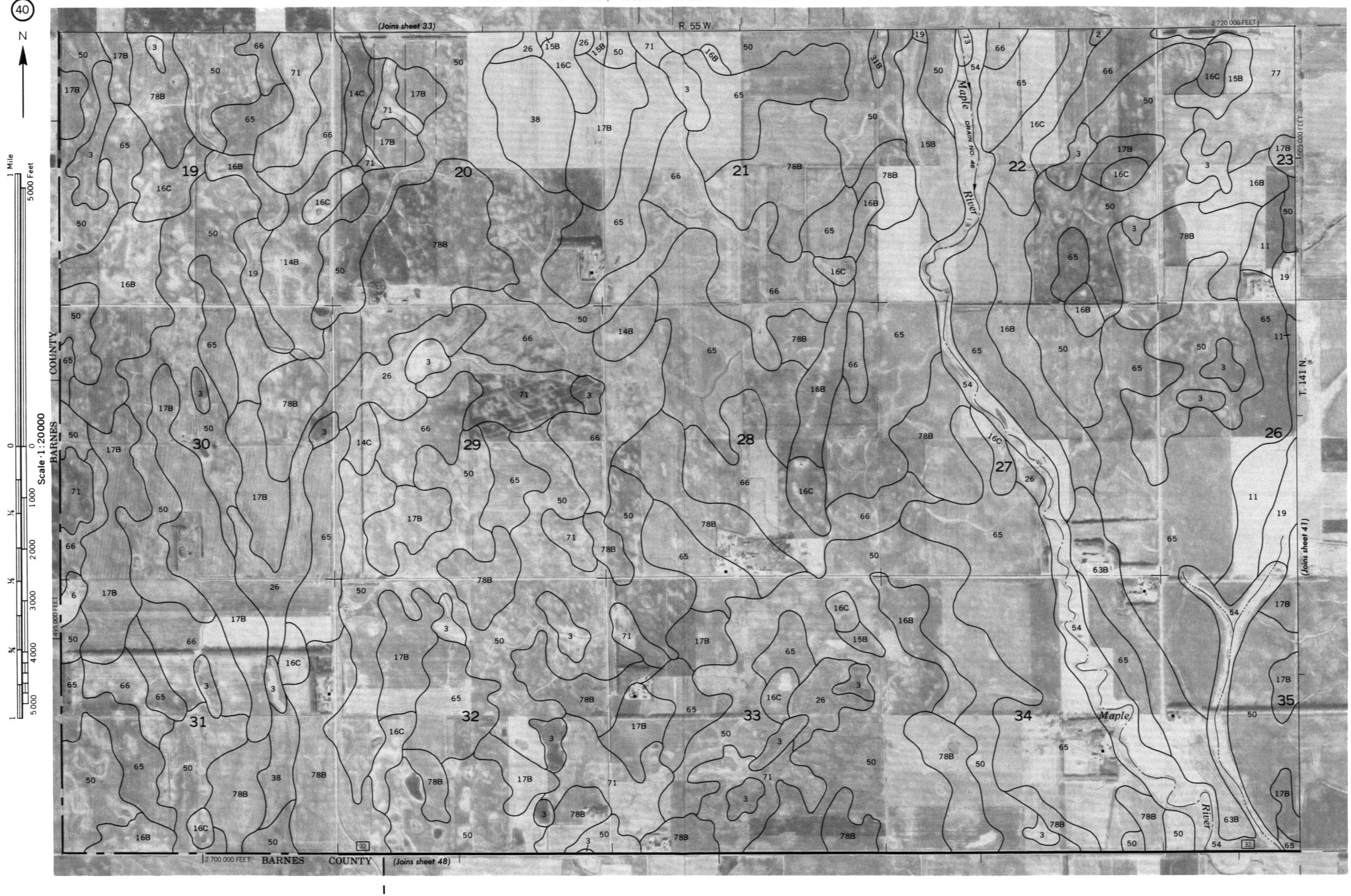


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

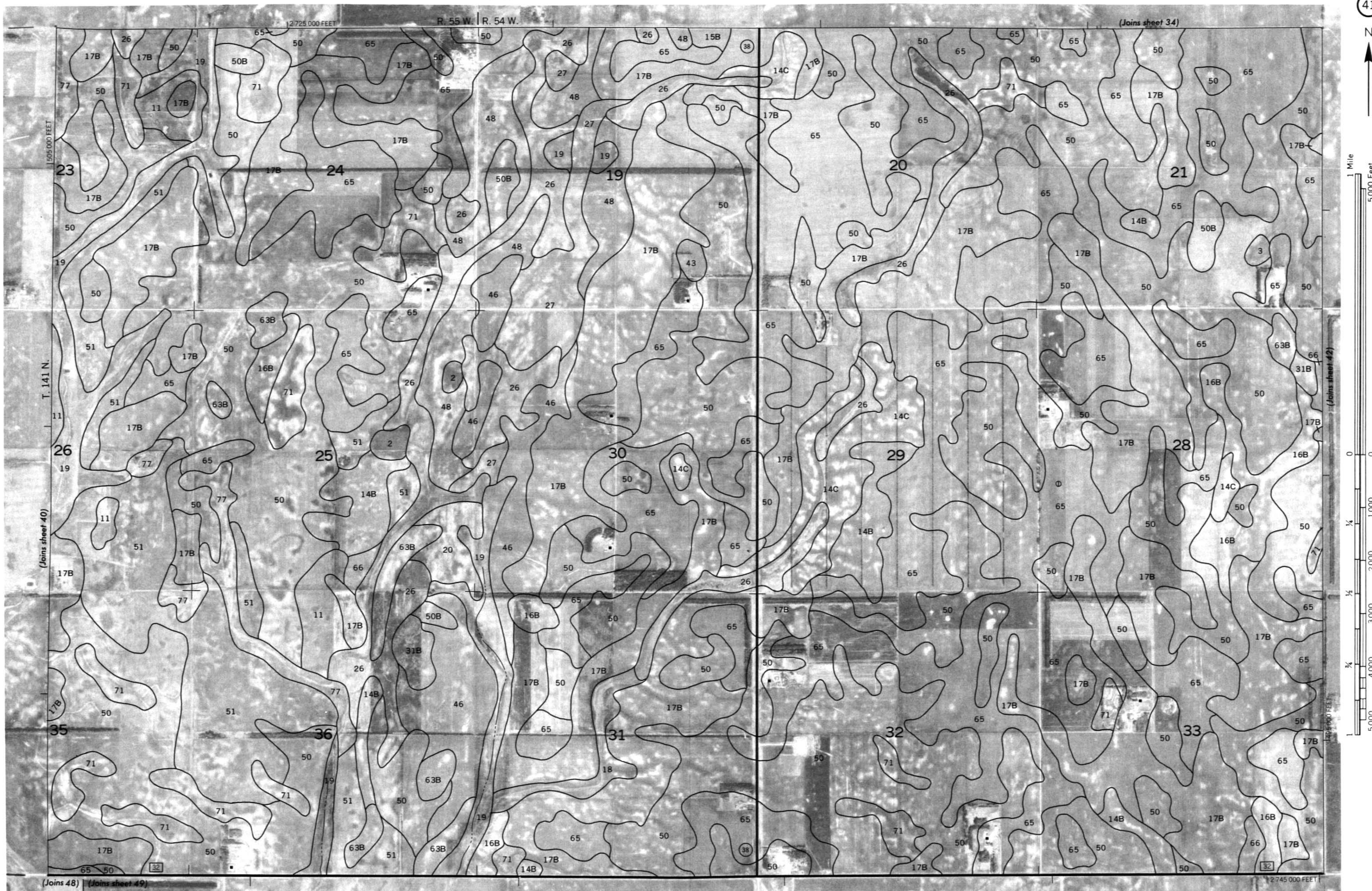


CASS COUNTY AREA, NORTH DAKOTA NO. 39

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



CASS COUNTY AREA, NORTH DAKOTA NO. 41

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

42

N

1 Mile

5000 Feet

Scale 1:20000

0 0 1000 2000 3000 4000 5000

¼ ½ ¾ 1

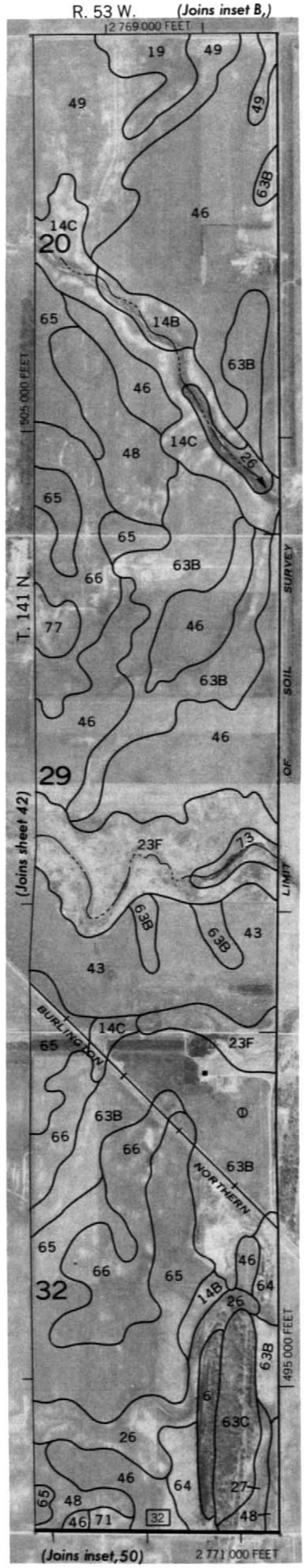
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA NO. 42

CASS COUNTY AREA, NORTH DAKOTA NO. 43

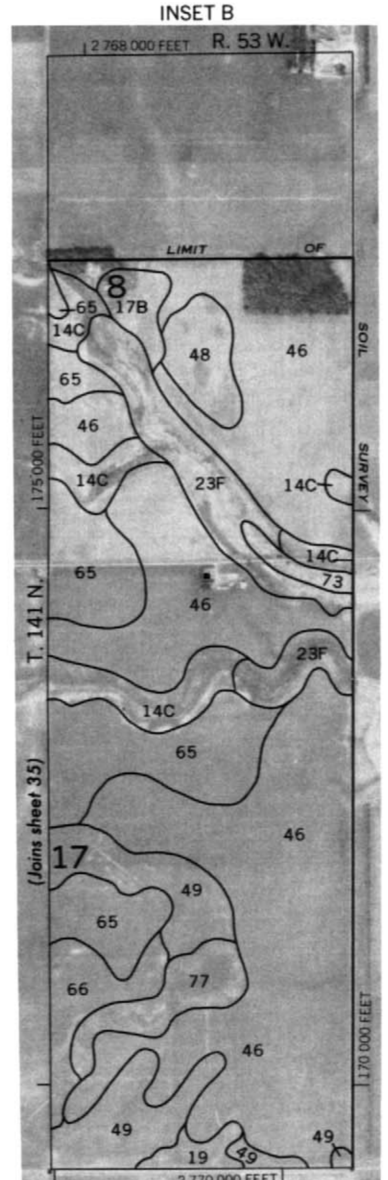
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

INSET C



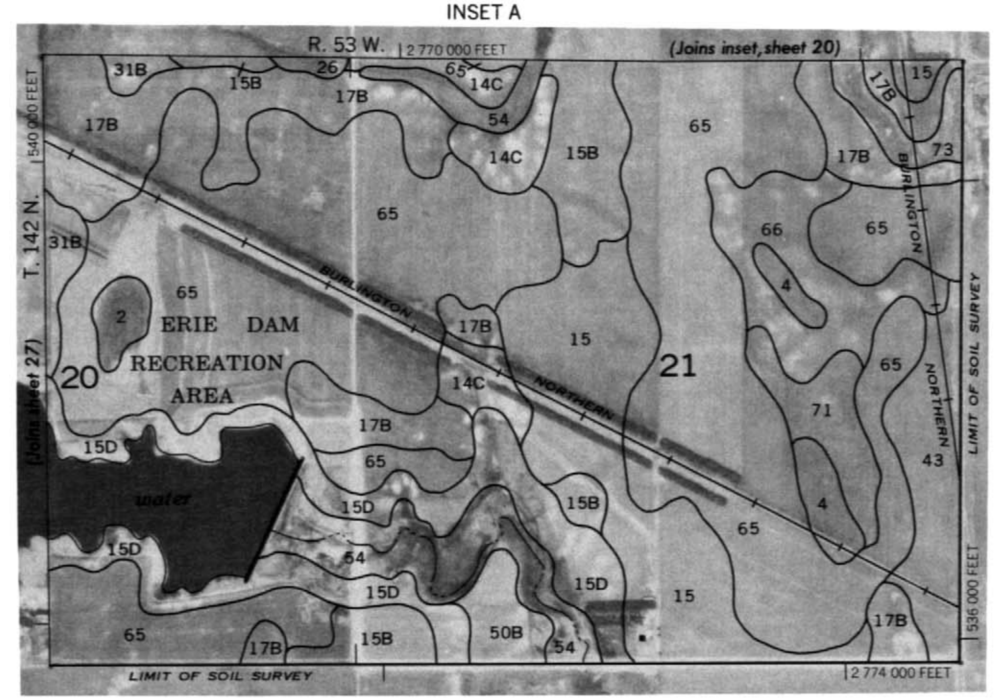
1000 AND 5000-FOOT GRID TICKS

INSET B

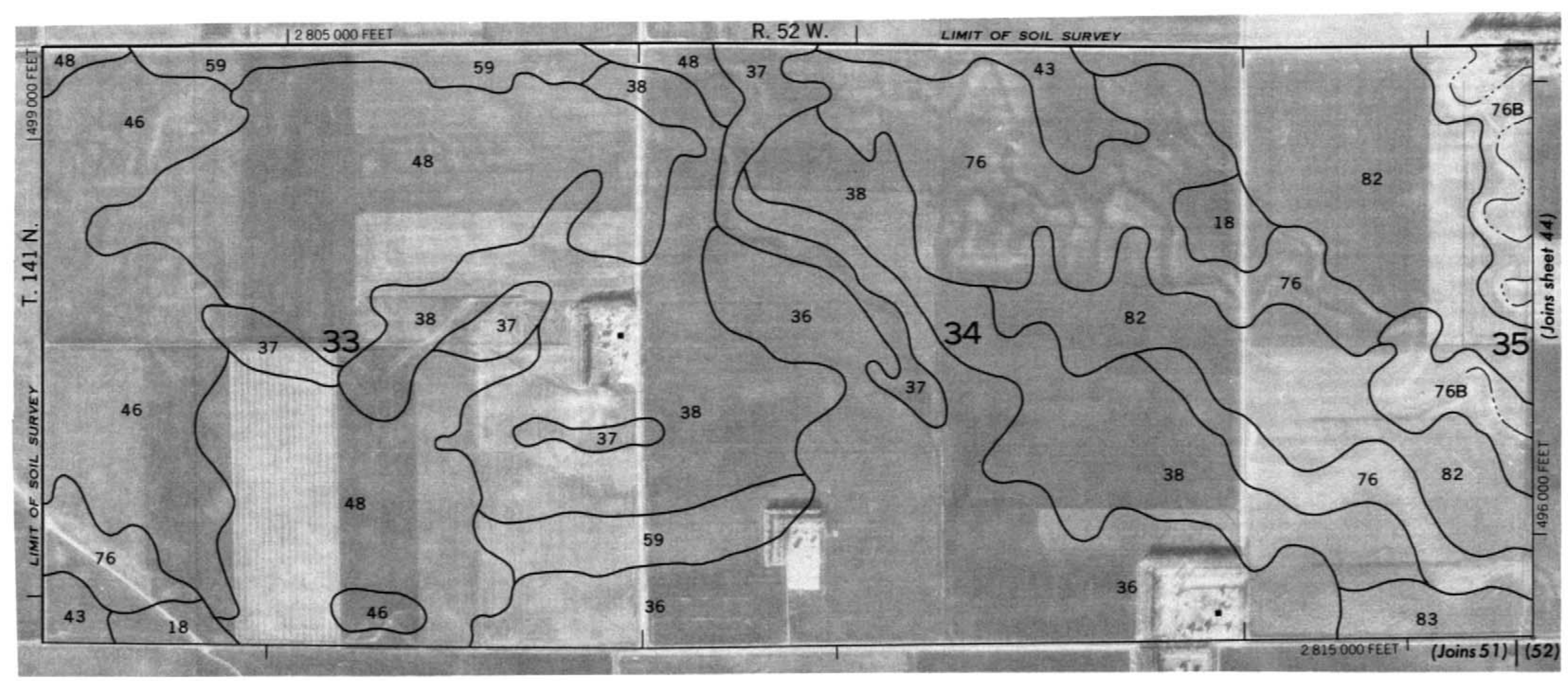


2000 AND 5000-FOOT GRID TICKS

INSET A

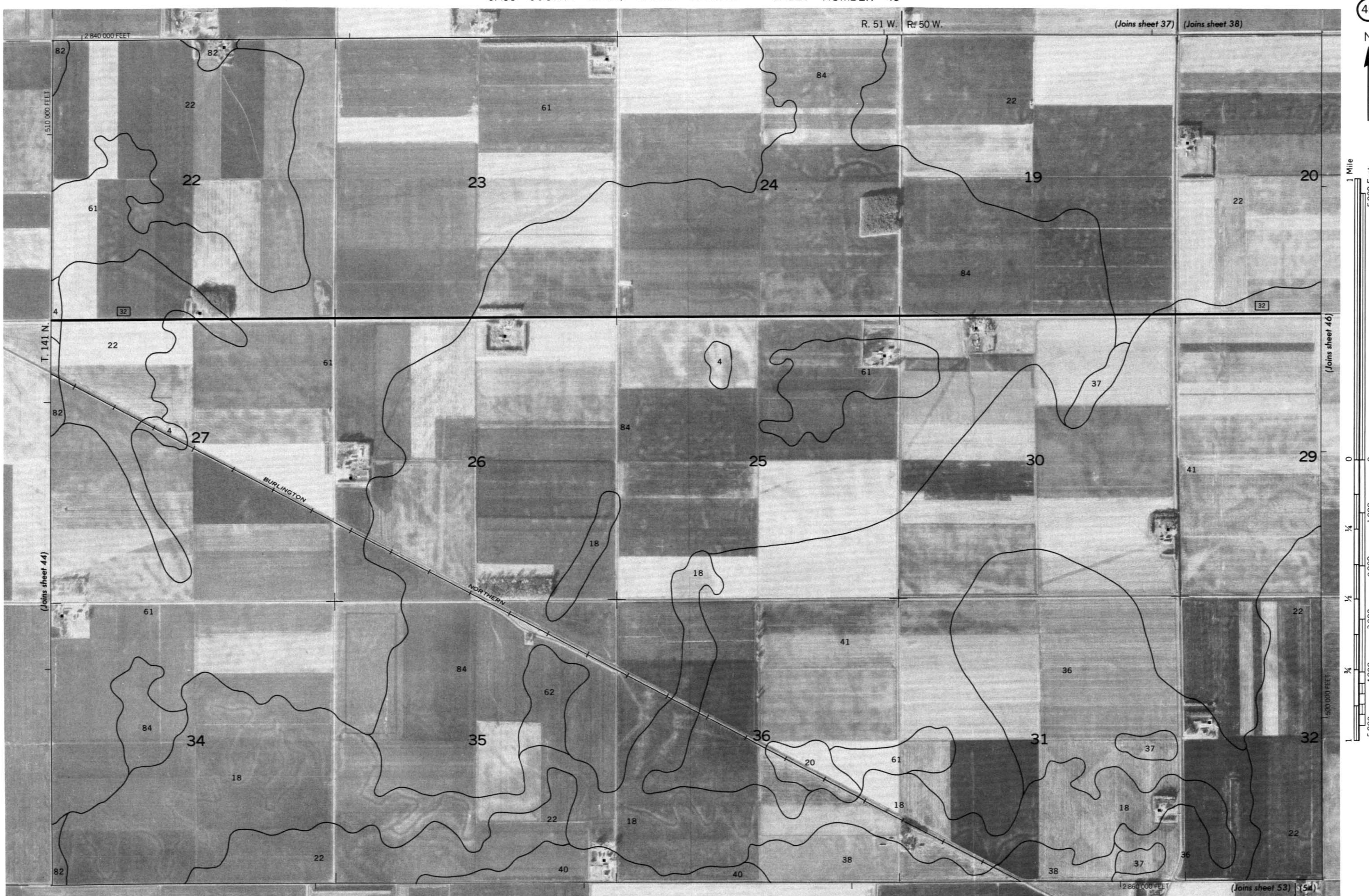


4000-FOOT GRID TICKS



4000 AND 5000-FOOT GRID TICKS

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



CASS COUNTY AREA, NORTH DAKOTA NO. 45

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

46

N

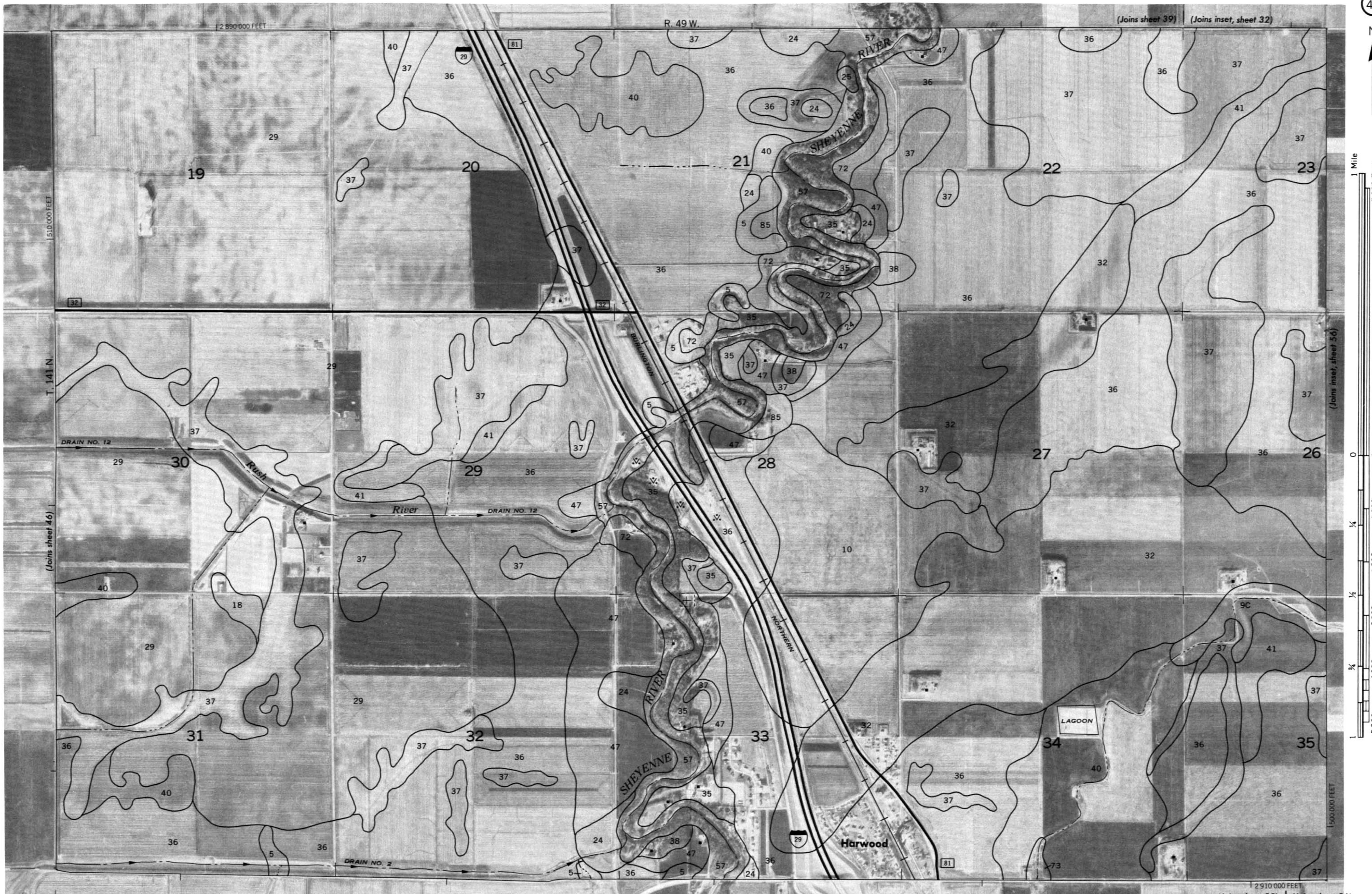
1 Mile
5000 Feet
0 ¼ ½ ¾ 1
0 1000 2000 3000 4000 5000
Scale 1:20000

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

47

CASS COUNTY AREA, NORTH DAKOTA NO. 47

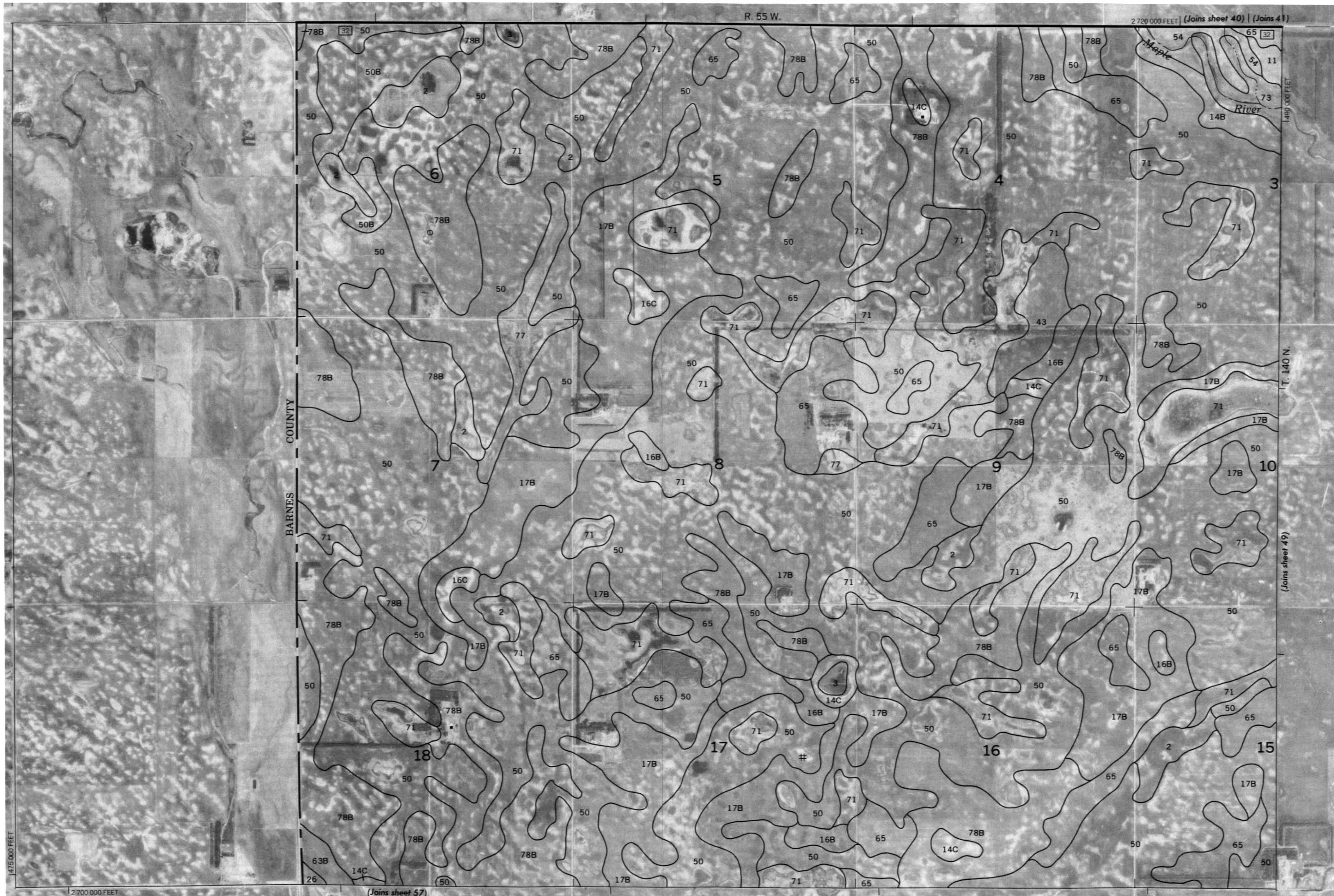
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



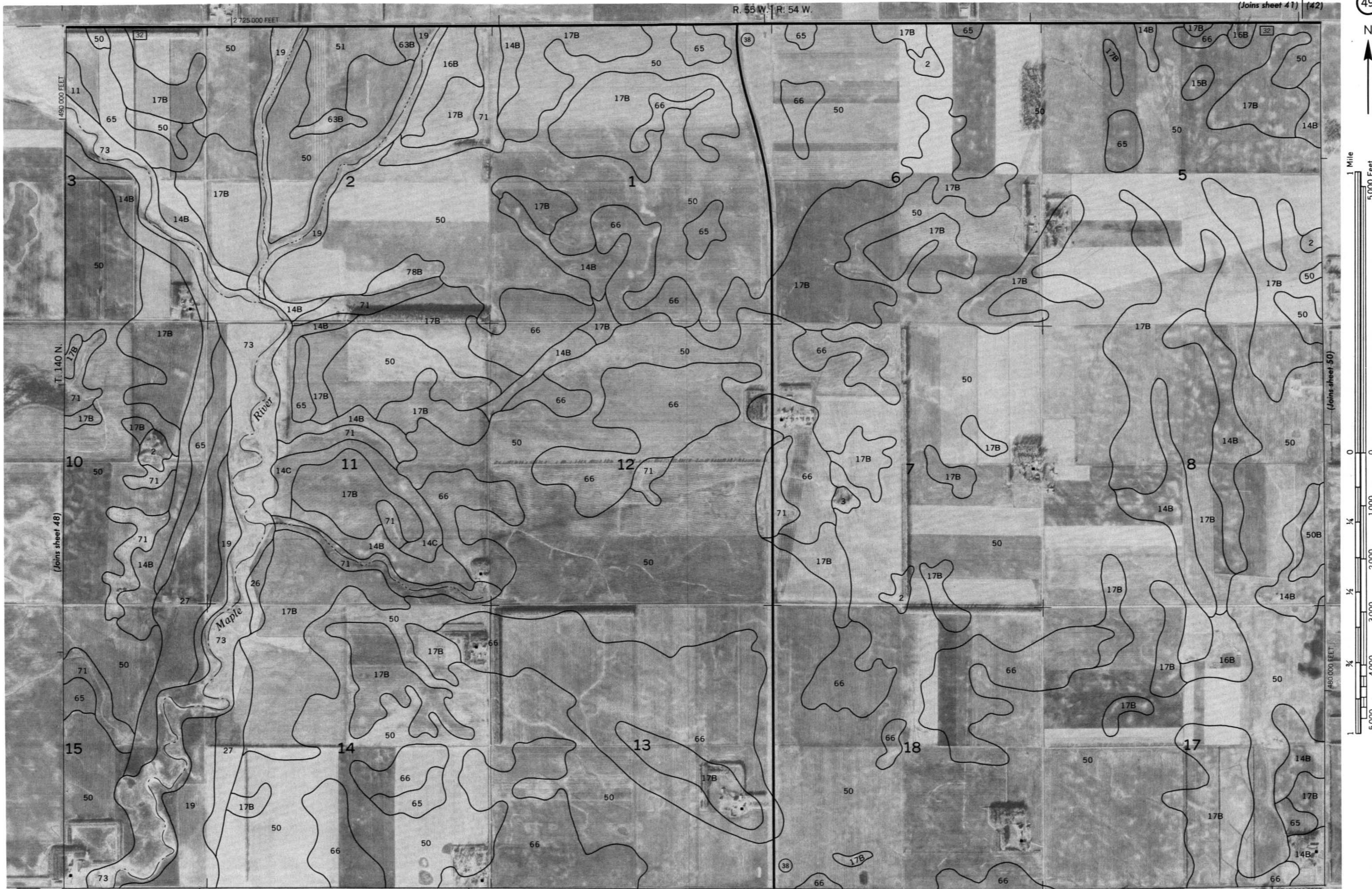
48

N

1 Mile
5000 Feet
0
0
Scale 1:20000
1000
¼
2000
½
3000
¾
4000
5000
1

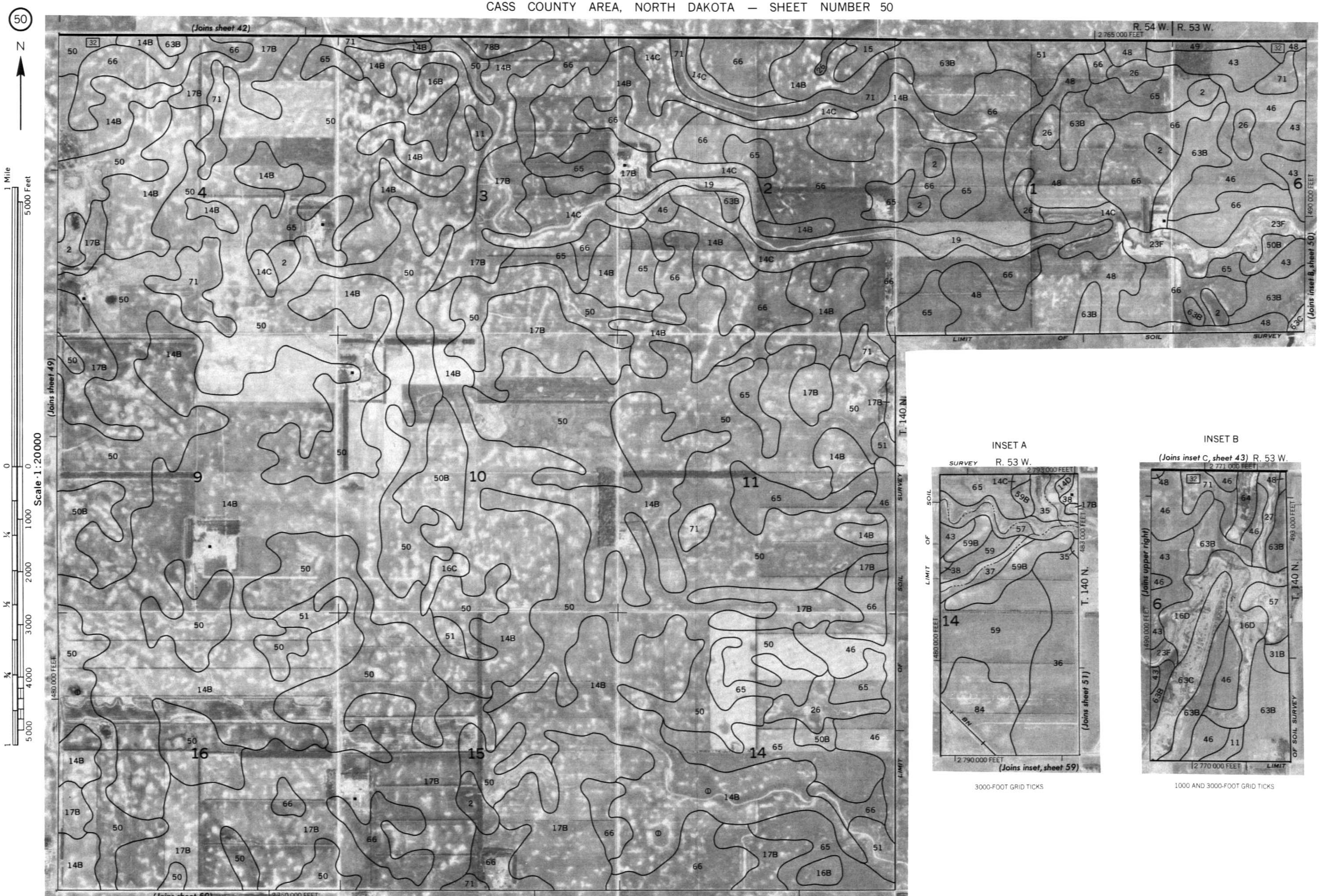


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



CASS COUNTY AREA, NORTH DAKOTA NO. 49

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



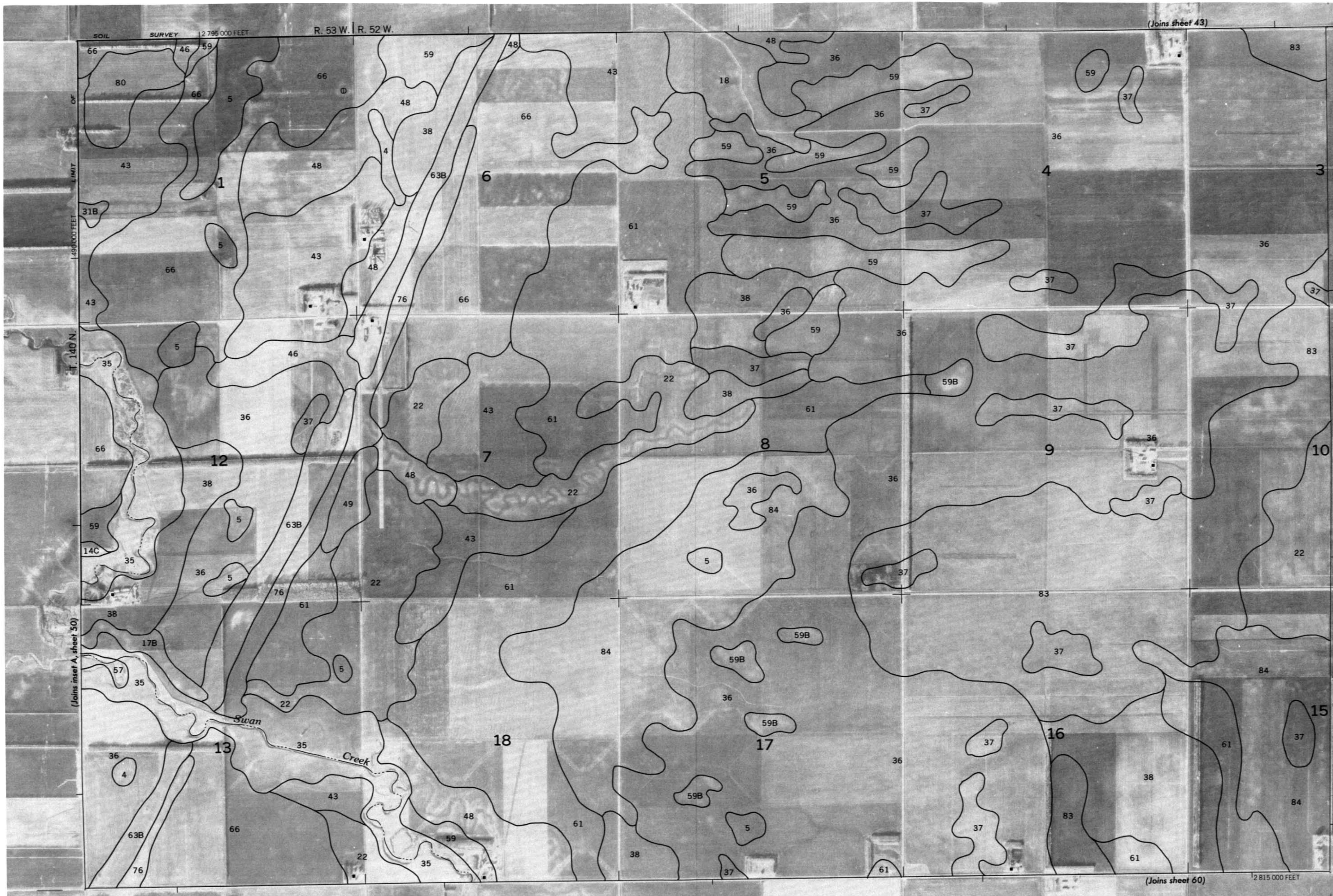
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA NO. 50

(51)

CASS COUNTY AREA, NORTH DAKOTA NO. 51

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

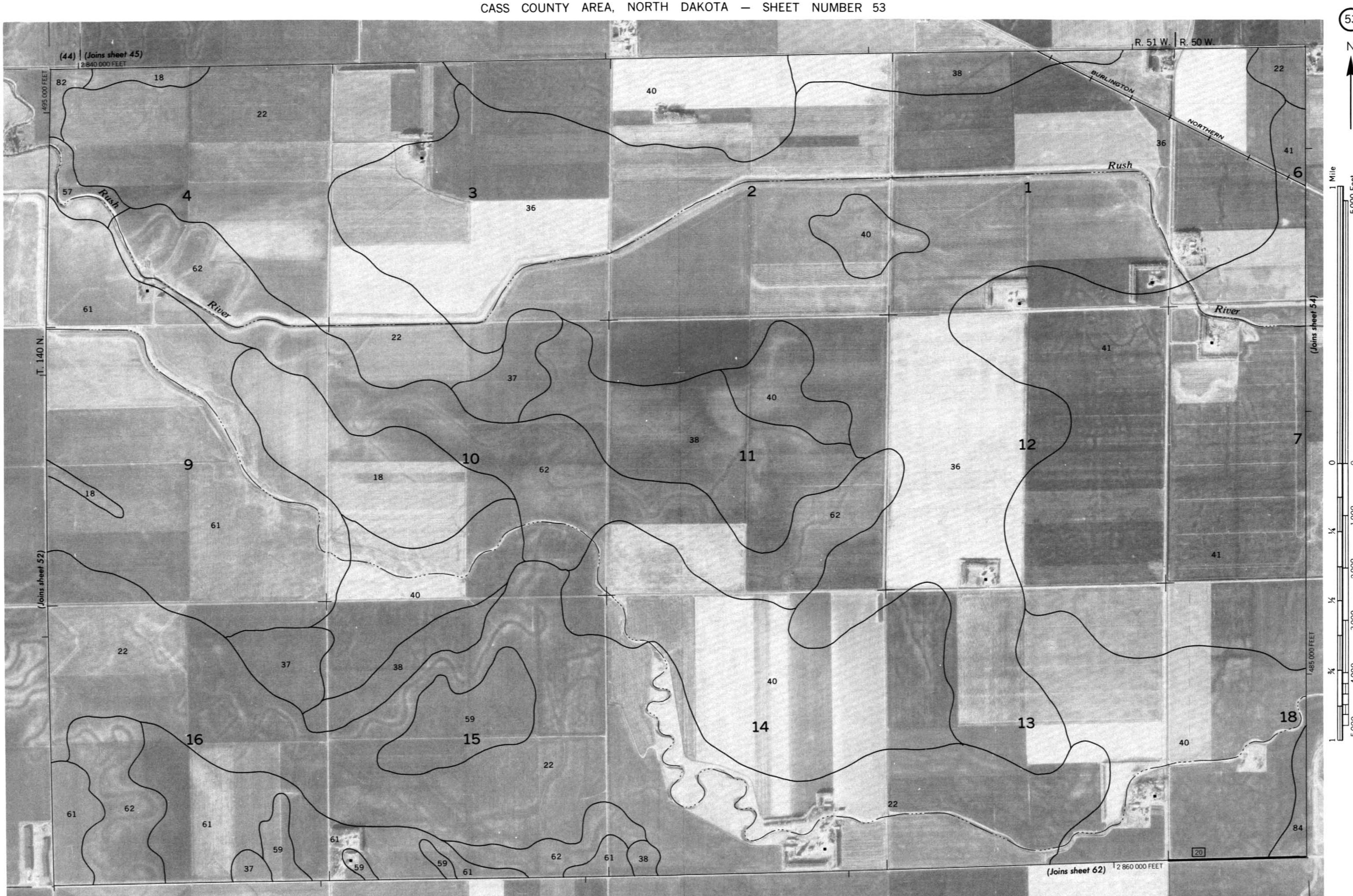


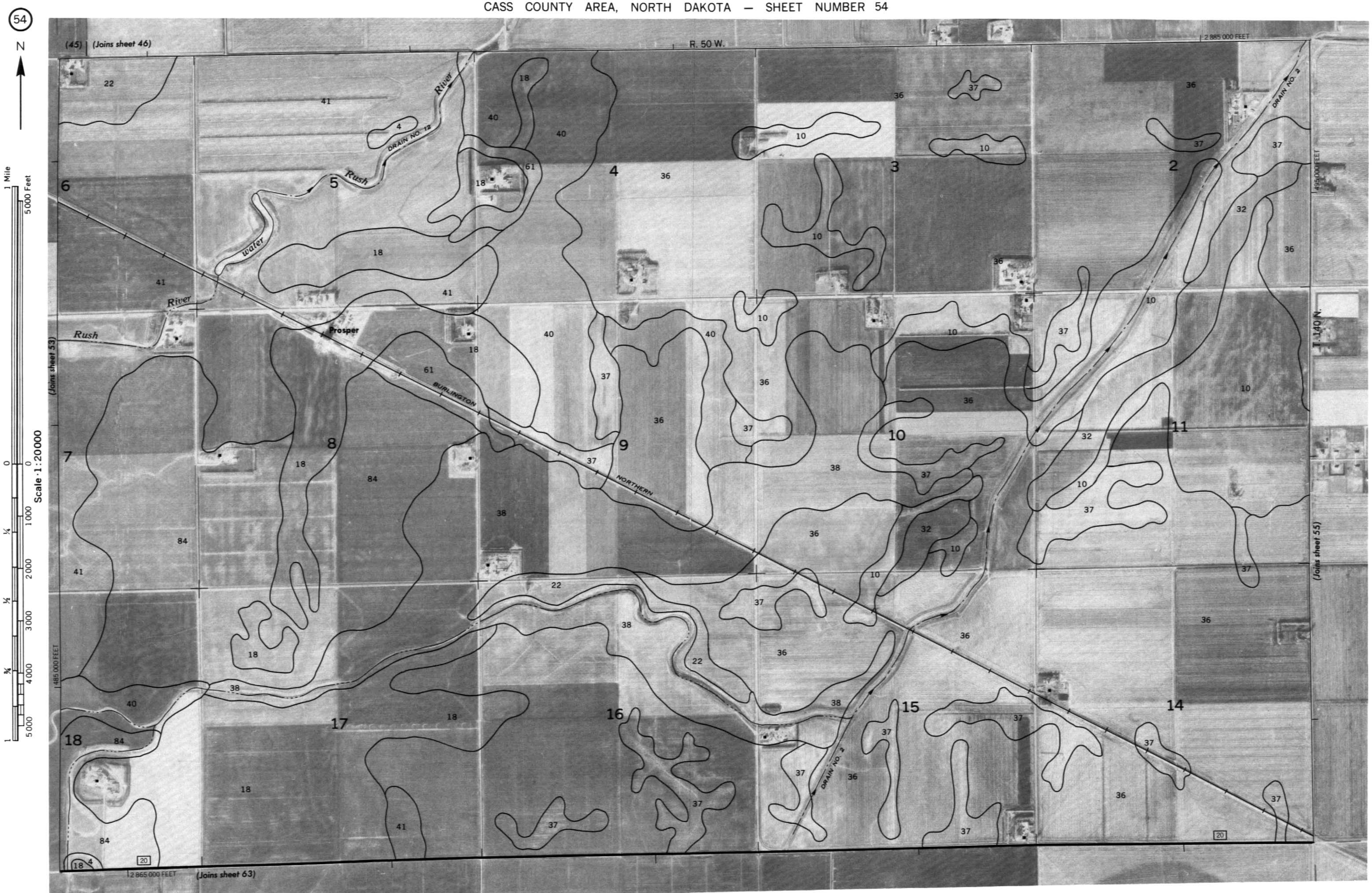
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA NO. 52

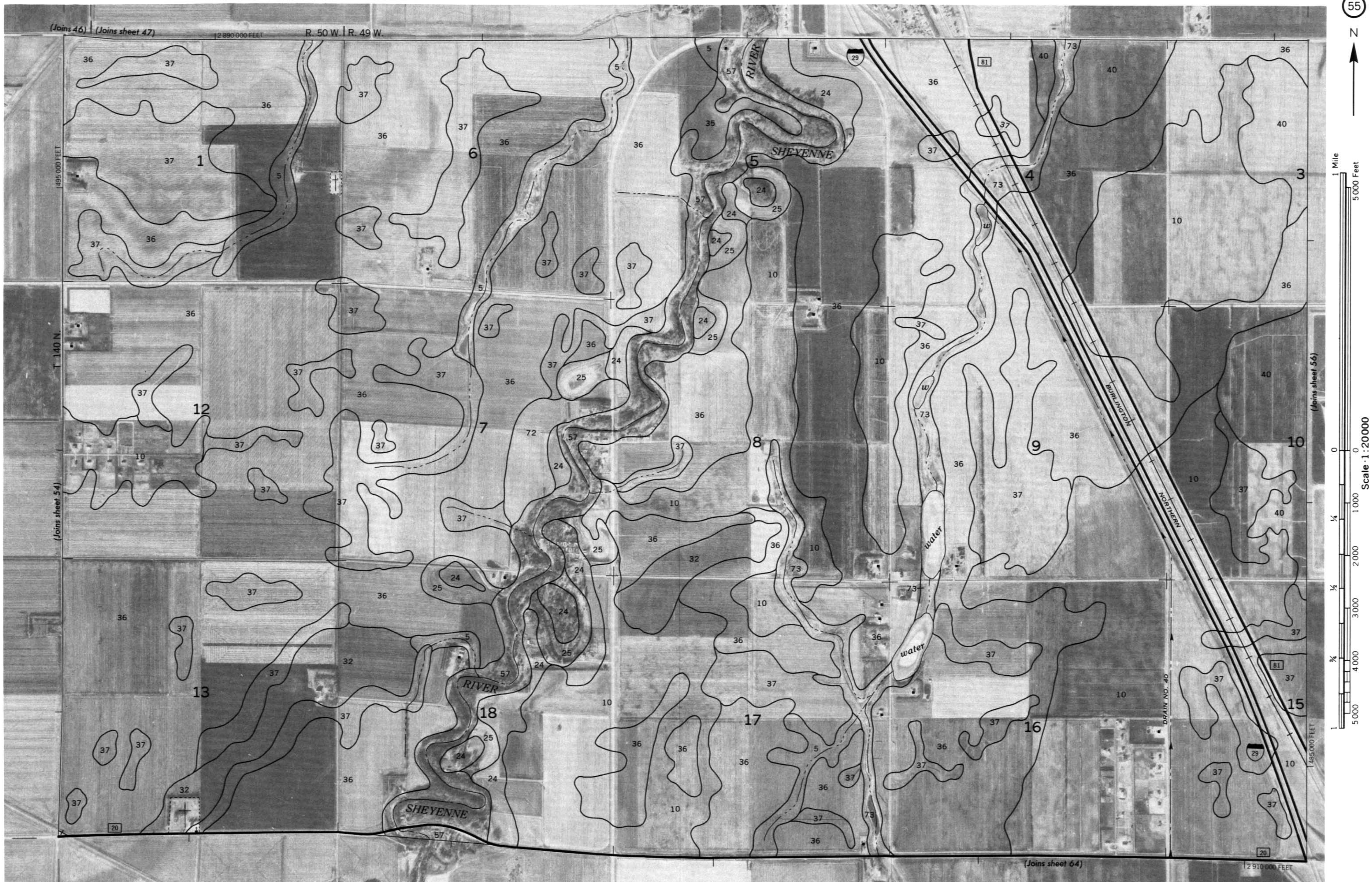
CASS COUNTY AREA, NORTH DAKOTA NO. 53

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



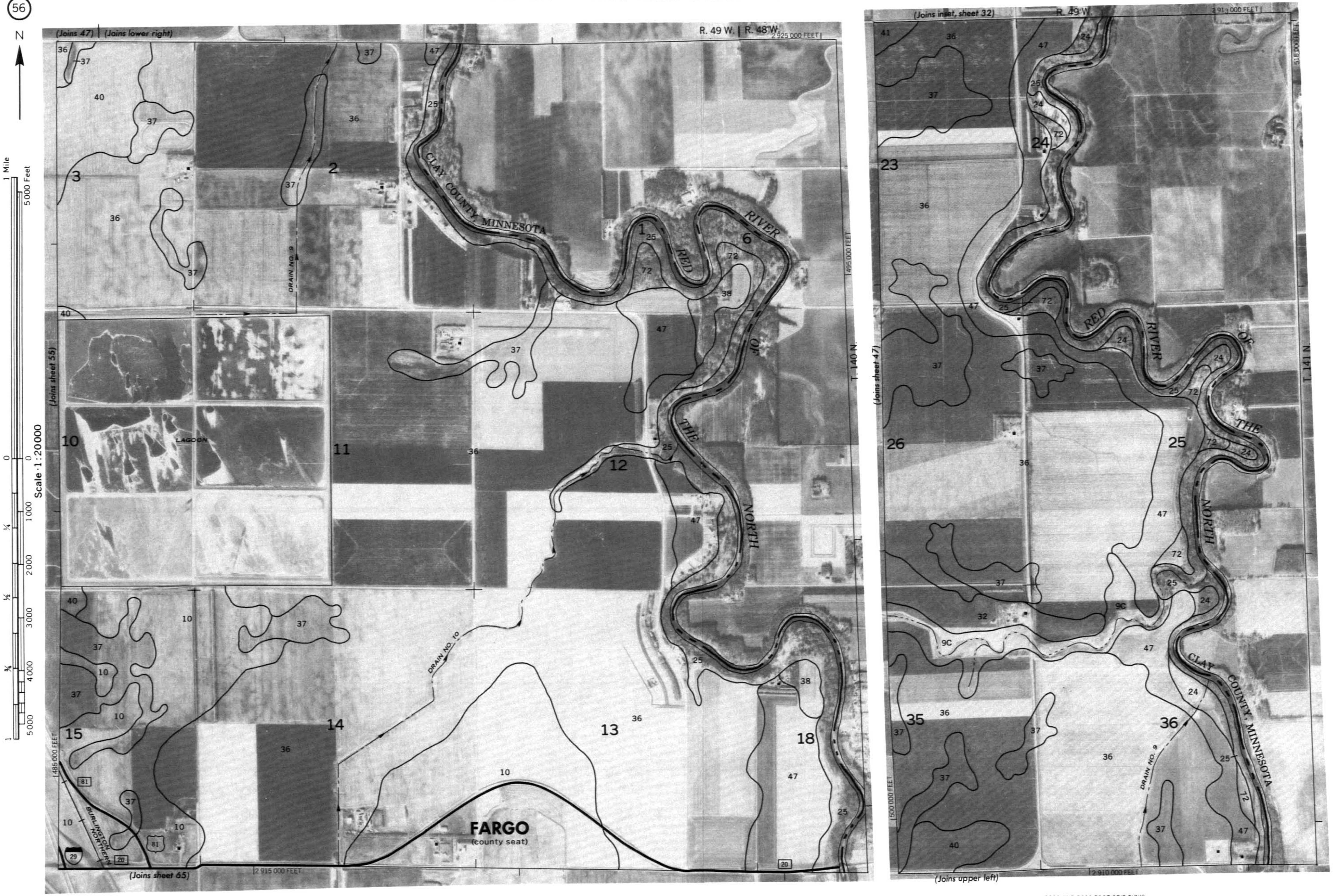


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



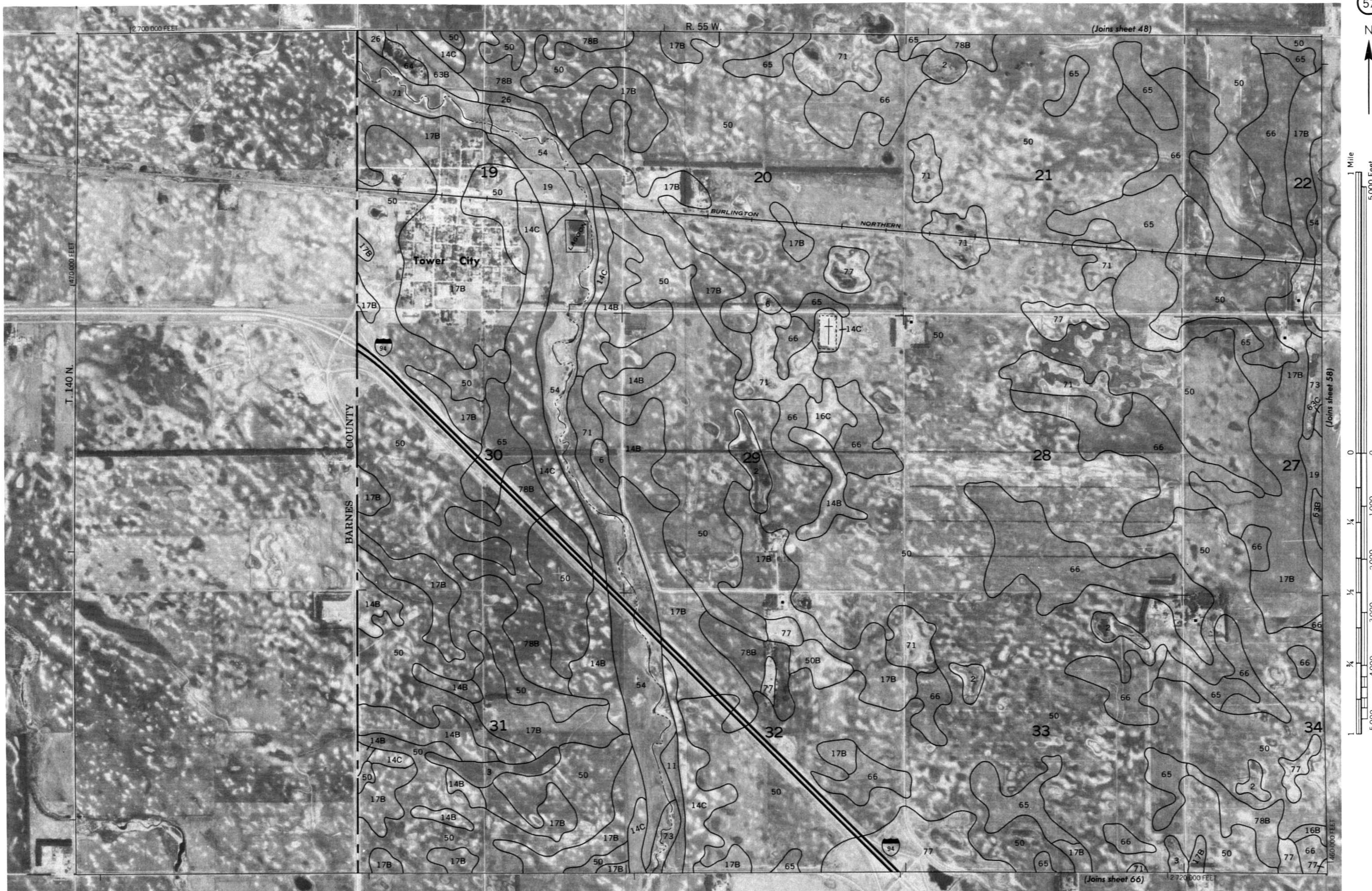
CASS COUNTY AREA, NORTH DAKOTA NO. 55

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



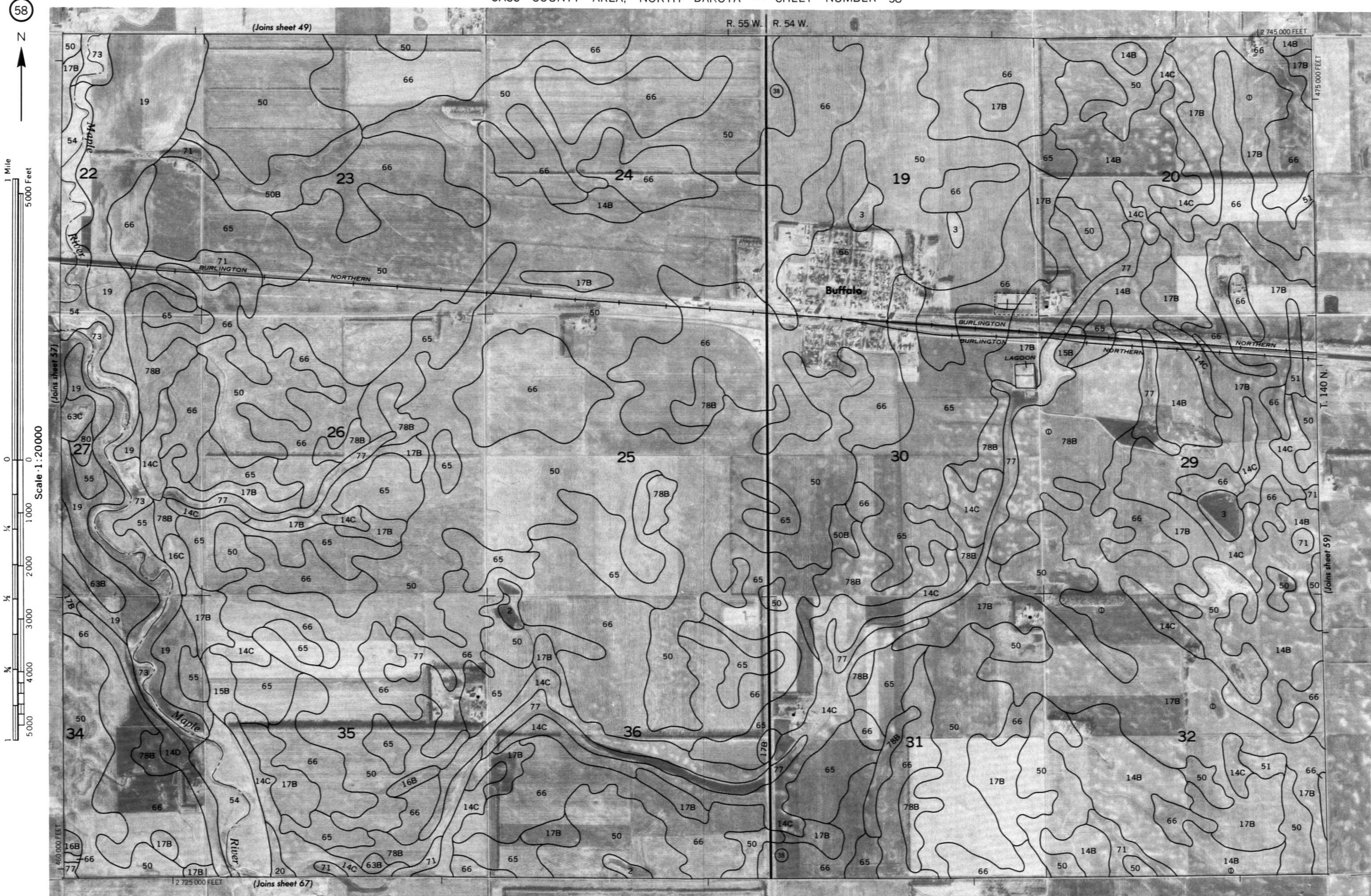
3000 AND 5000-FOOT GRID TICKS

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



CASS COUNTY AREA, NORTH DAKOTA NO. 57

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

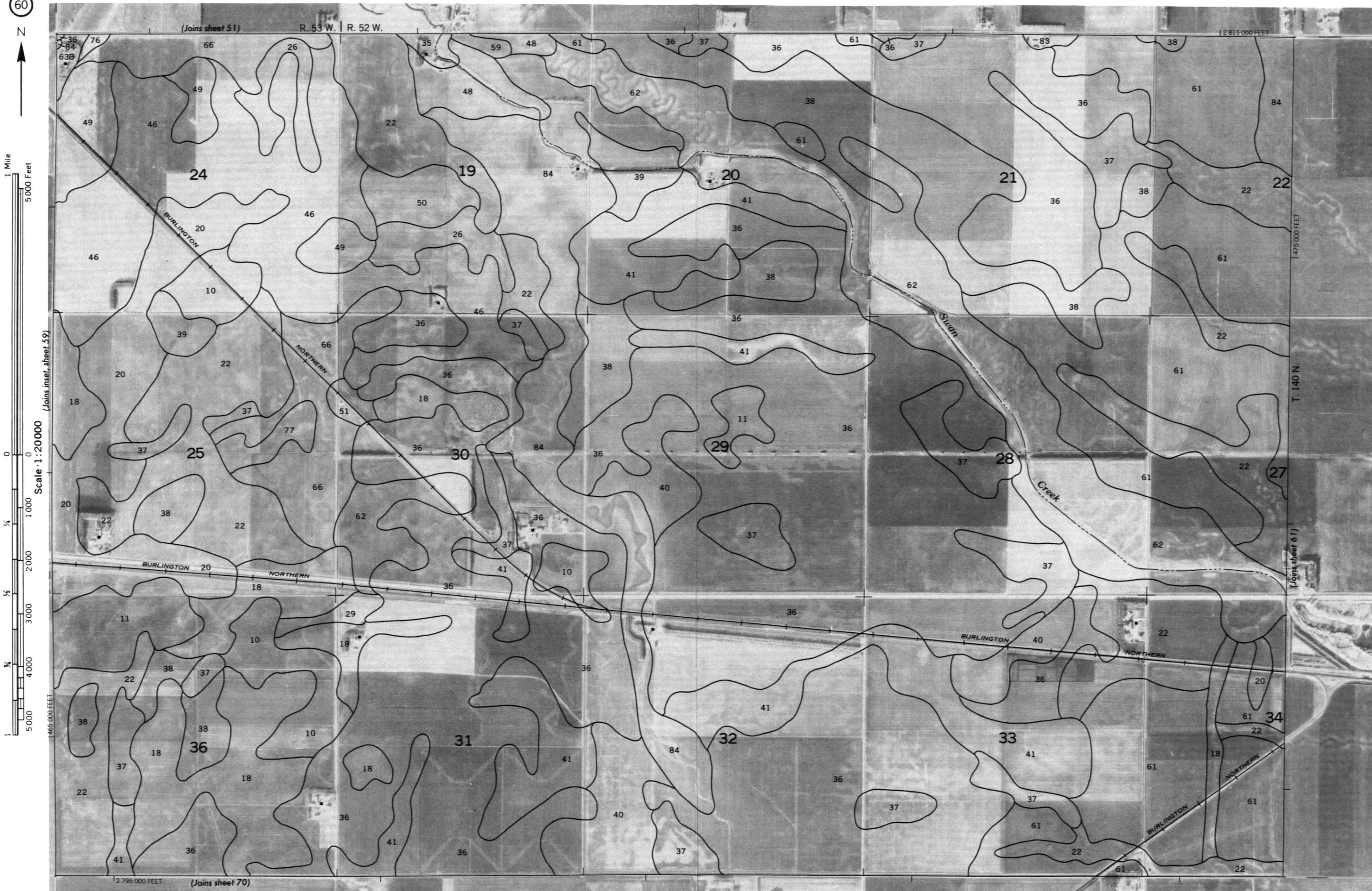


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

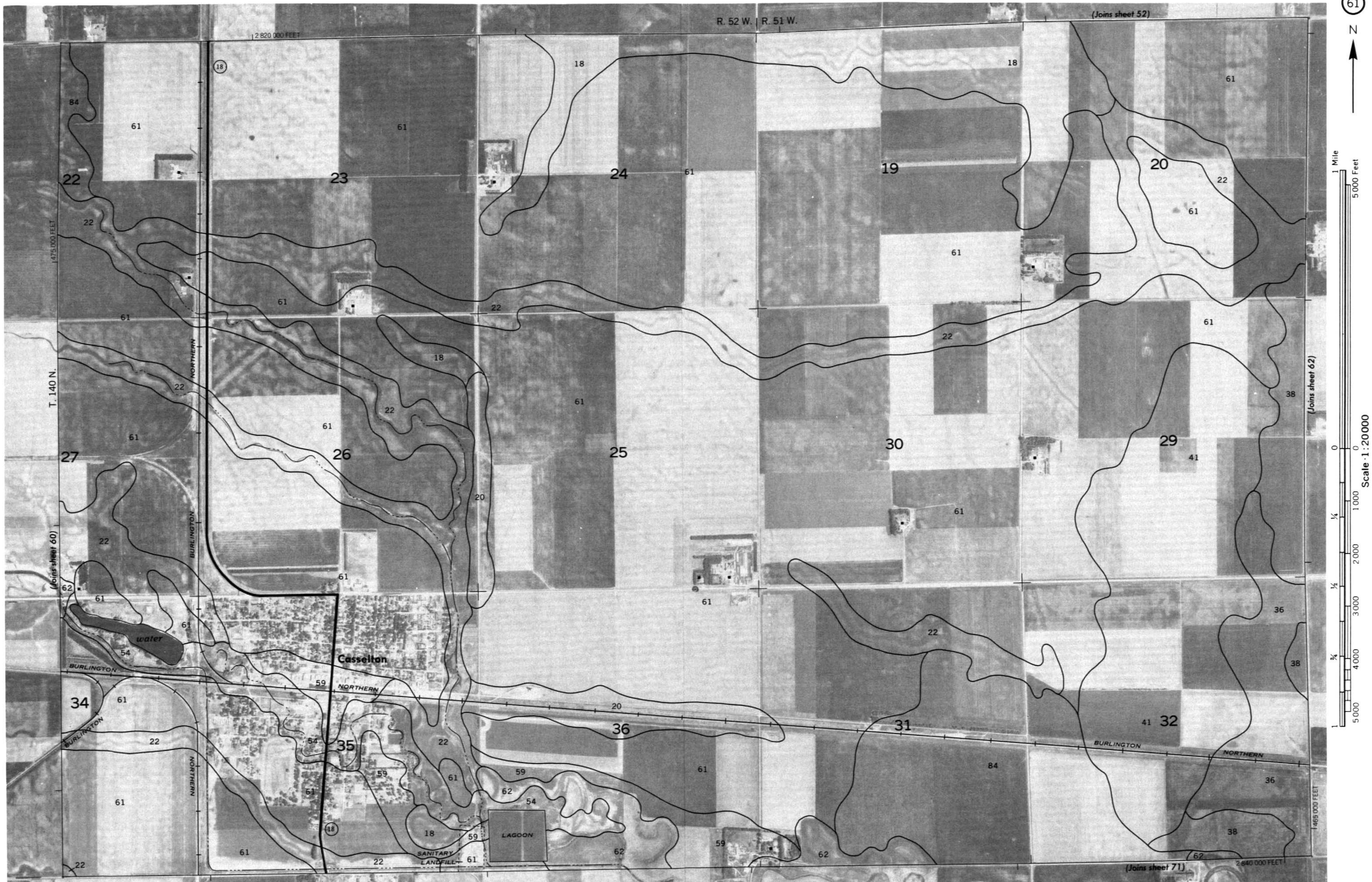
CASS COUNTY AREA, NORTH DAKOTA NO. 59

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

3000 AND 5000-FOOT GRID TICKS

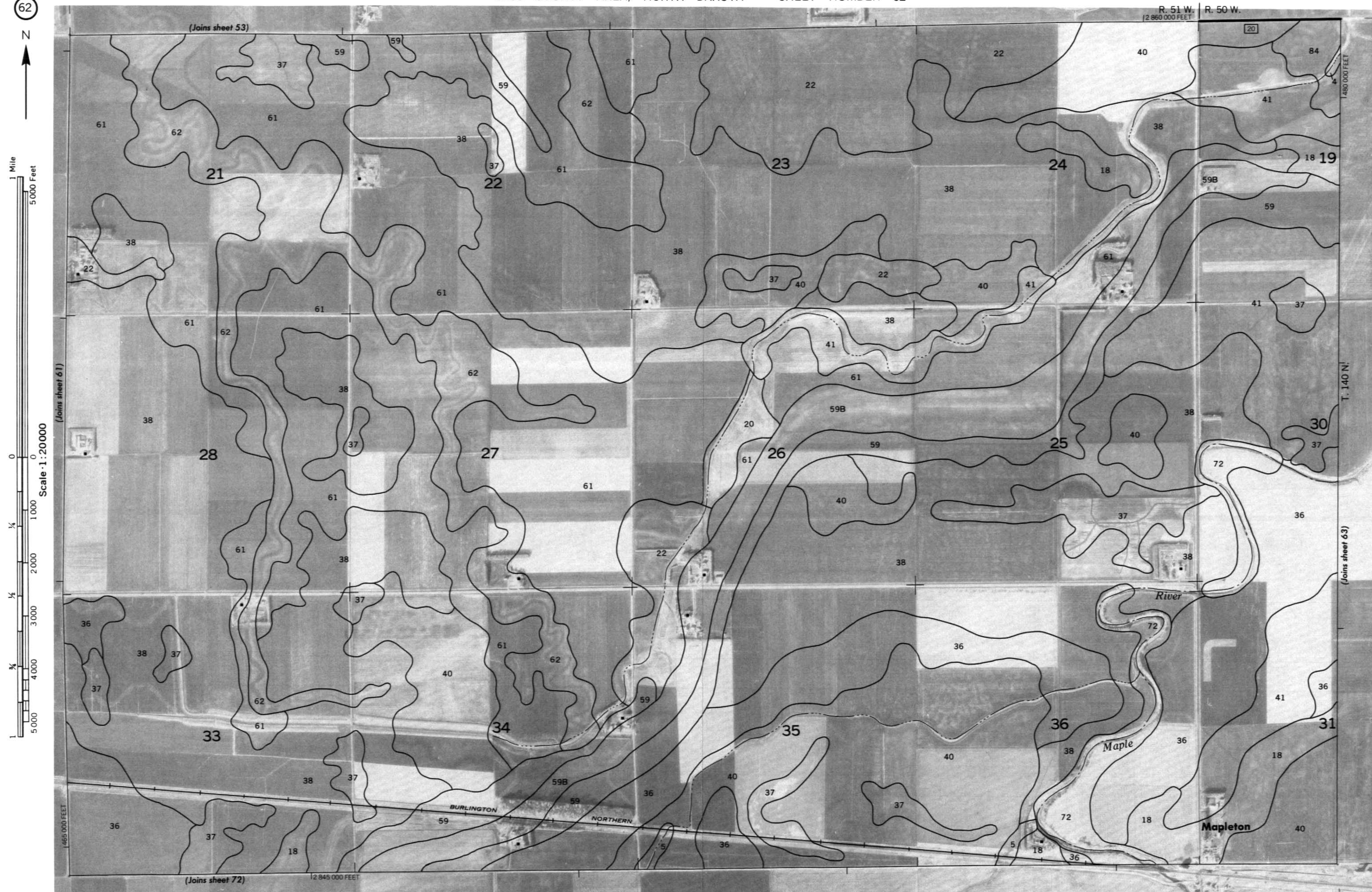


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



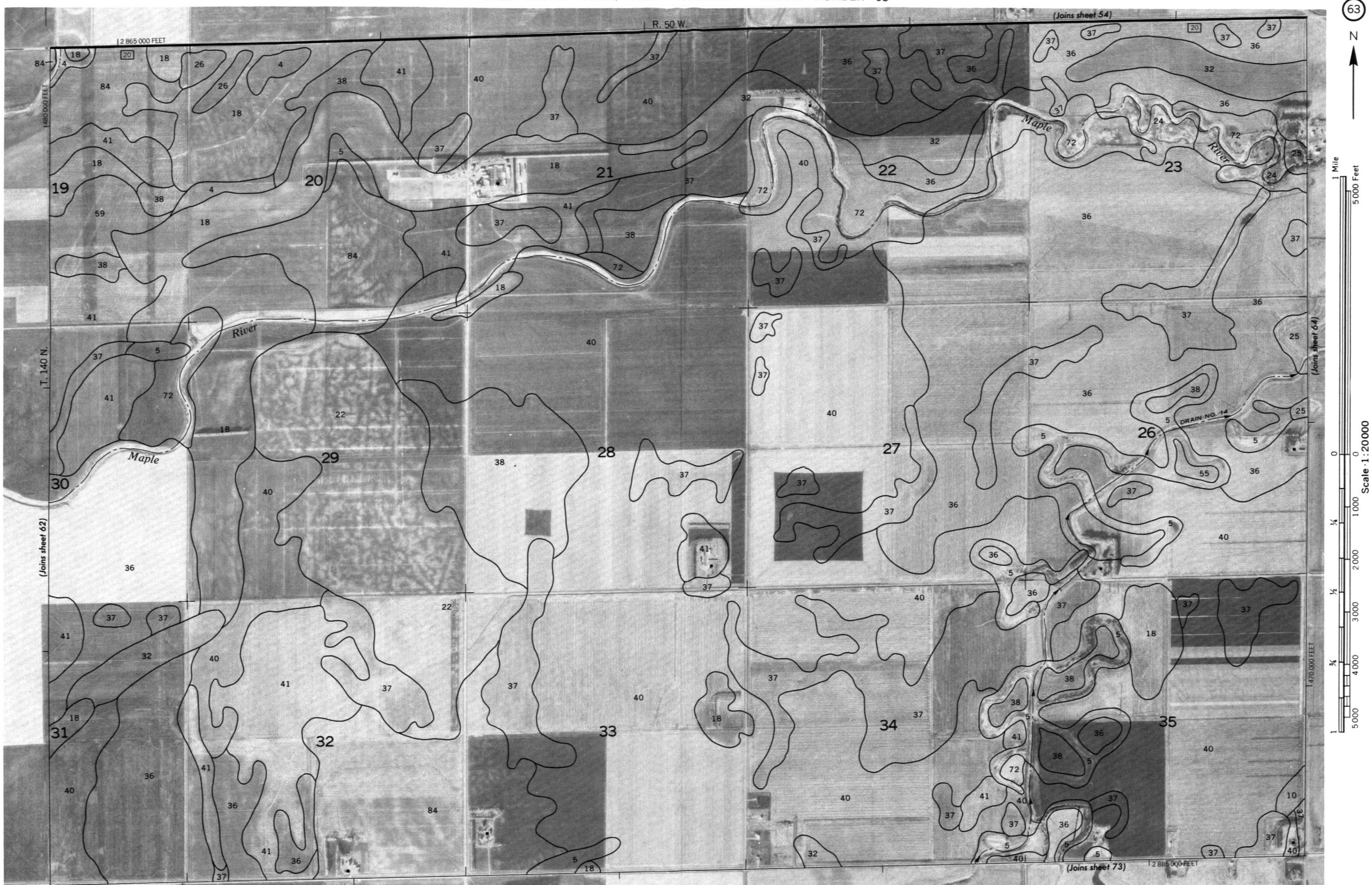
CASS COUNTY AREA, NORTH DAKOTA NO. 61

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA NO. 62



CASS COUNTY AREA, NORTH DAKOTA NO. 63

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA NO. 65
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

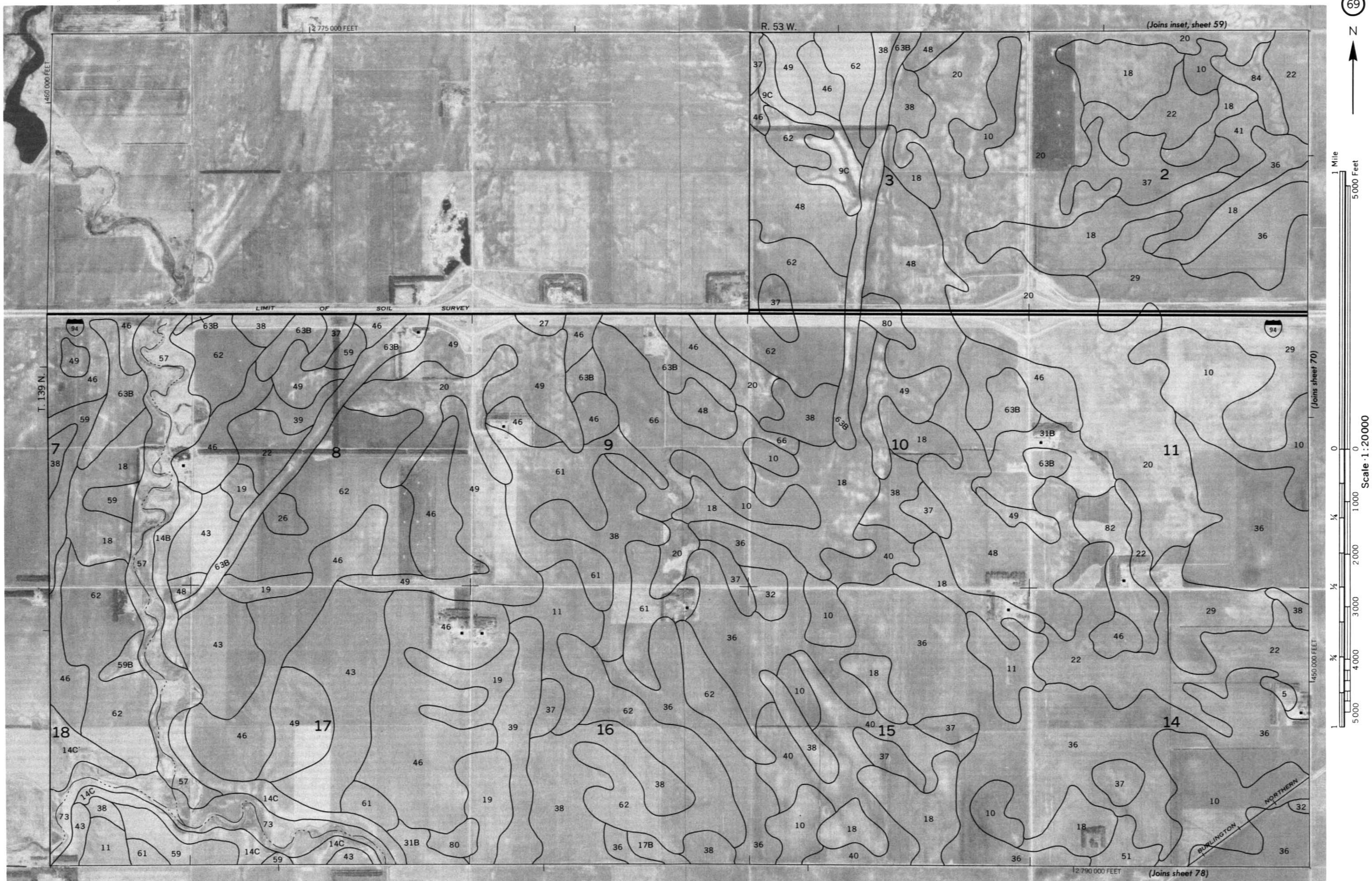
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA NO. 67

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA NO. 68



CASS COUNTY AREA, NORTH DAKOTA NO. 69

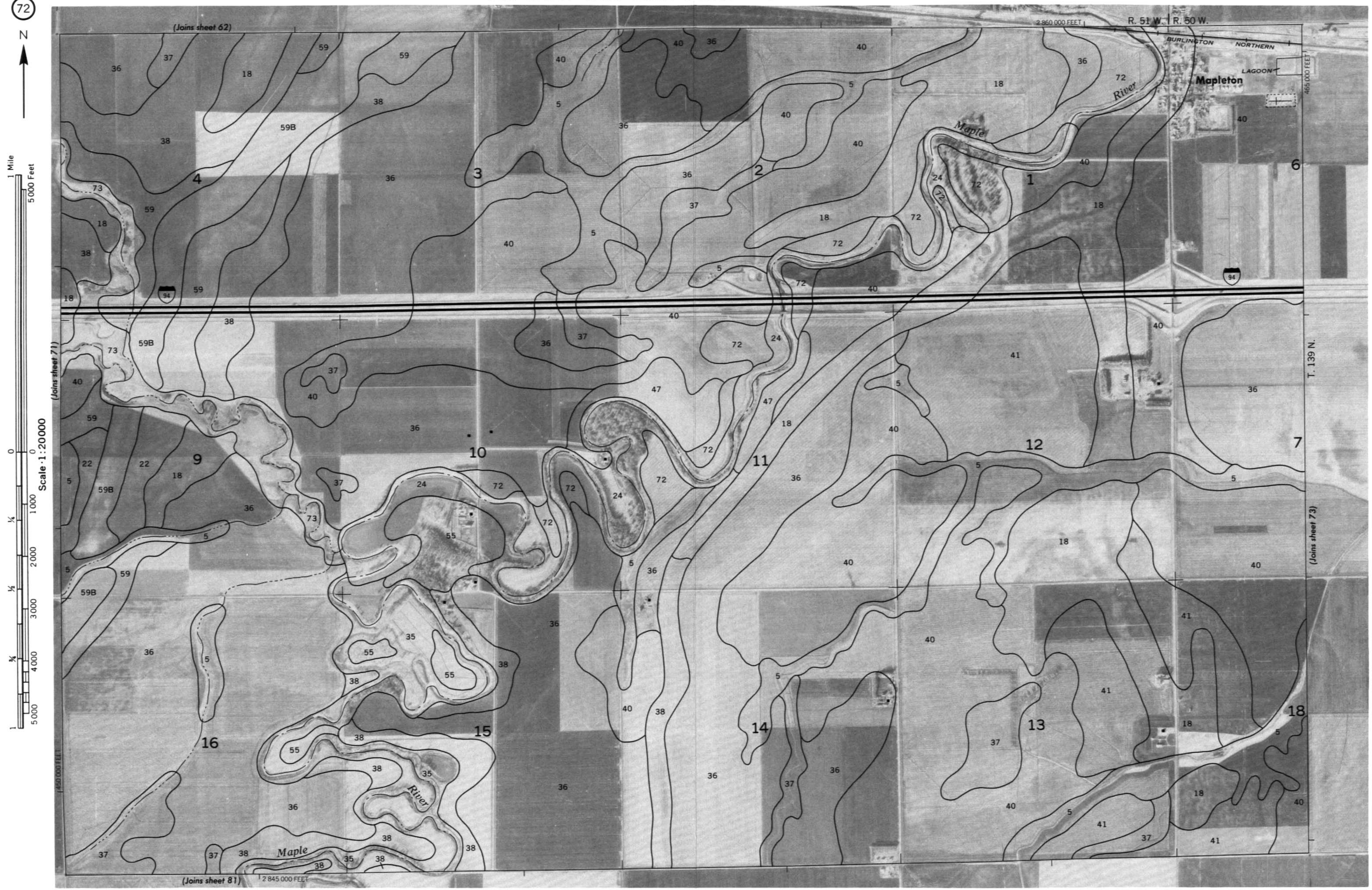
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA — SHEET NUMBER 70

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA NO. 71

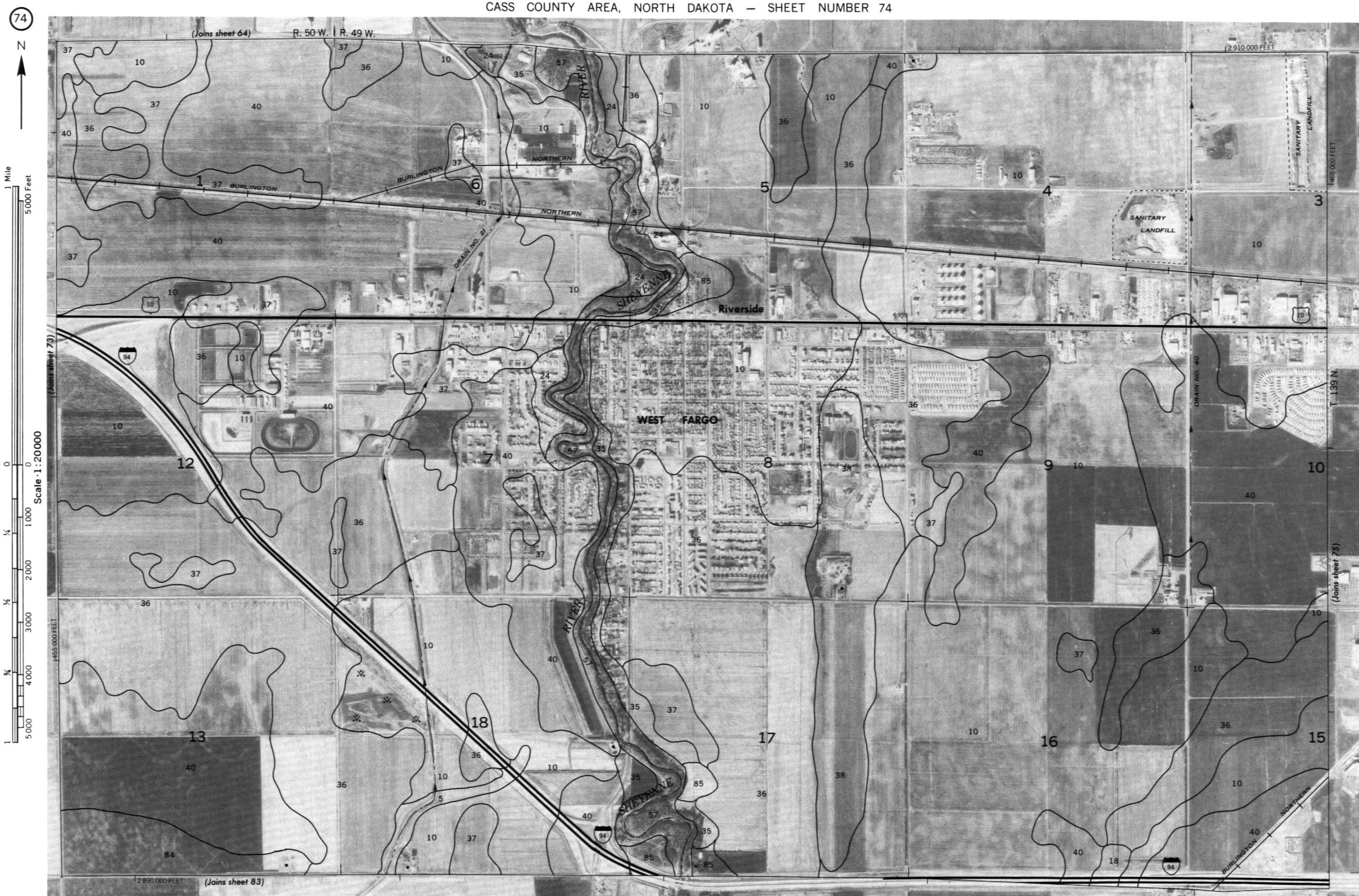
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



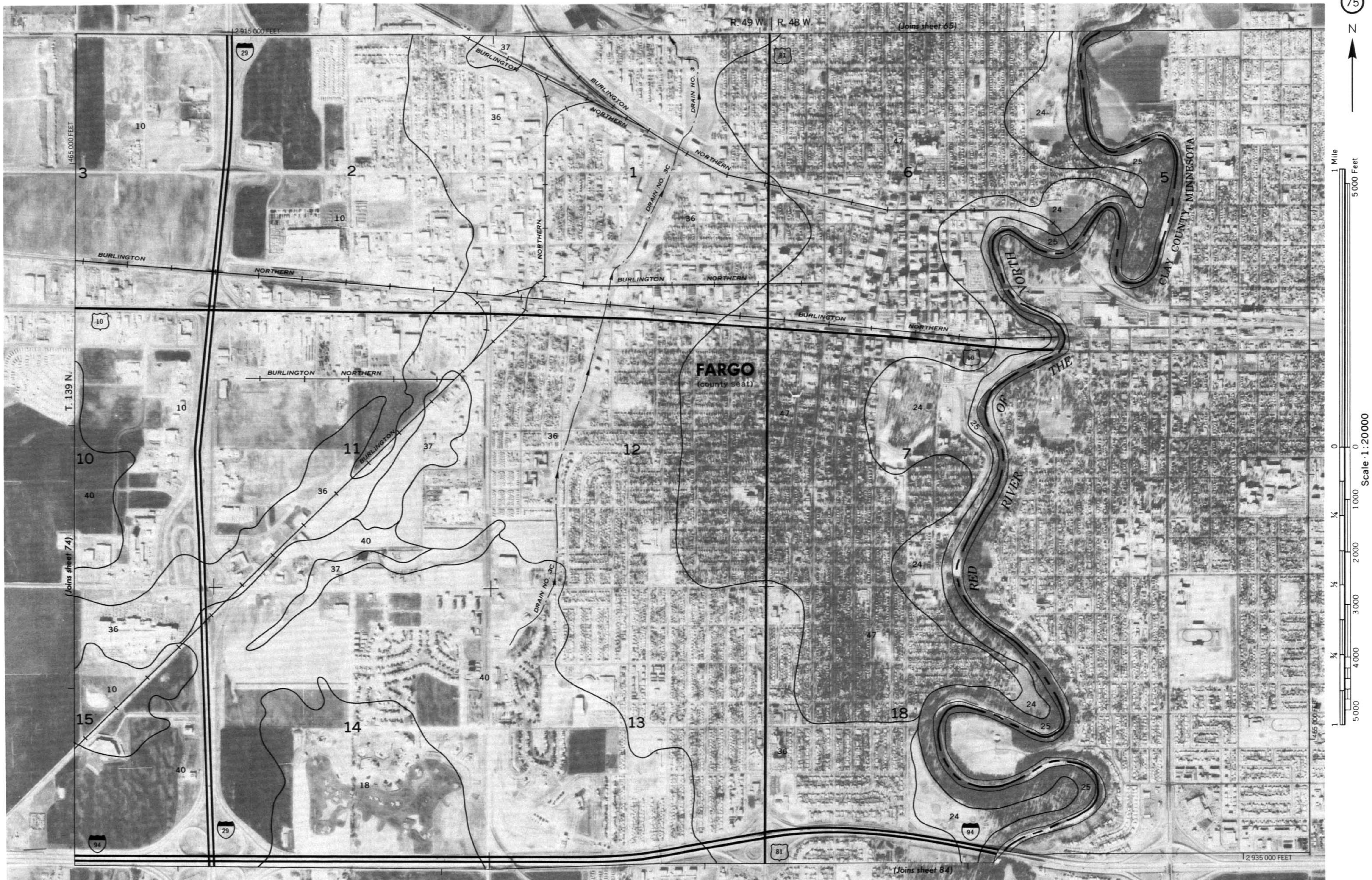
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA NO. 73

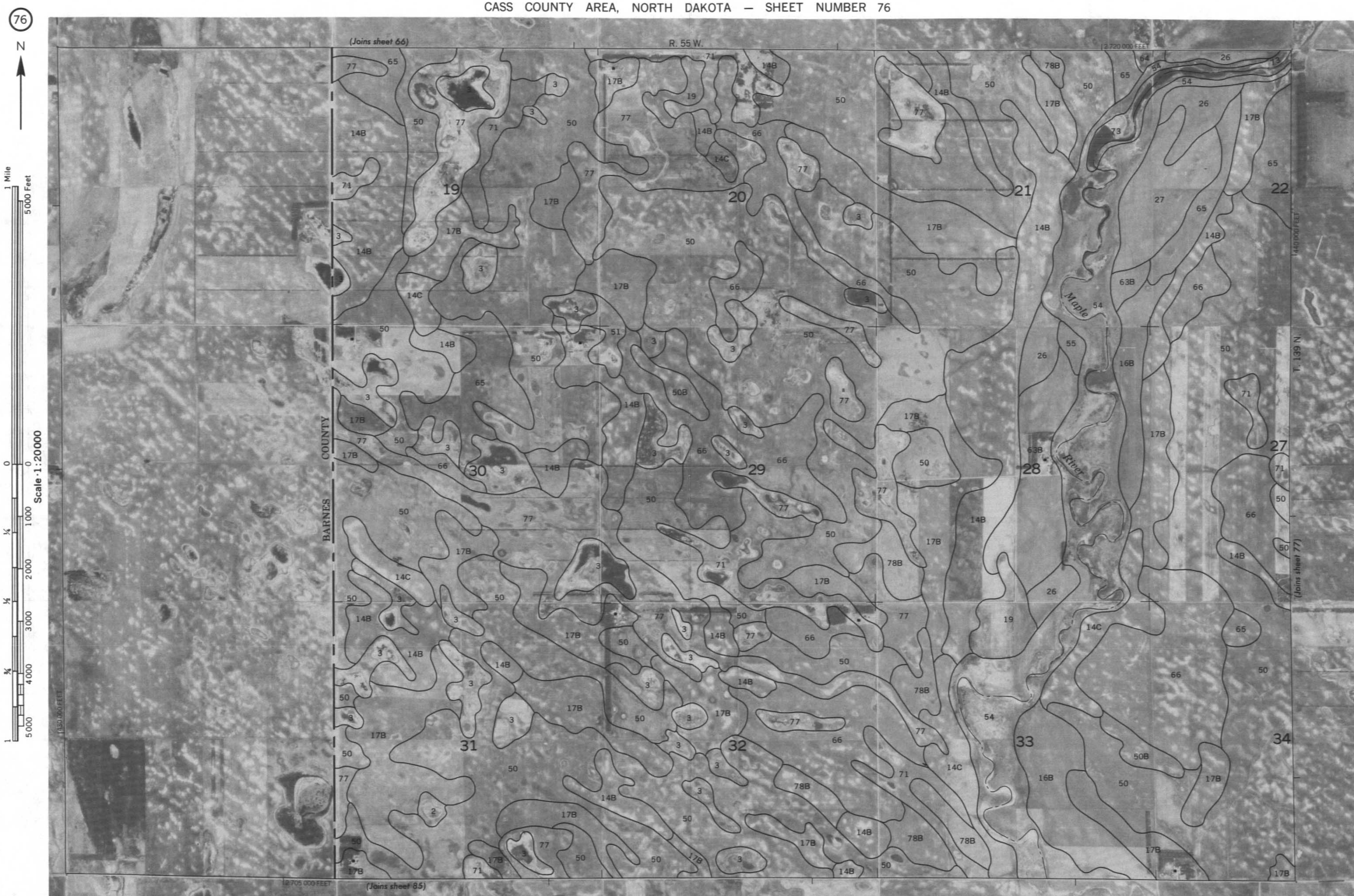
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

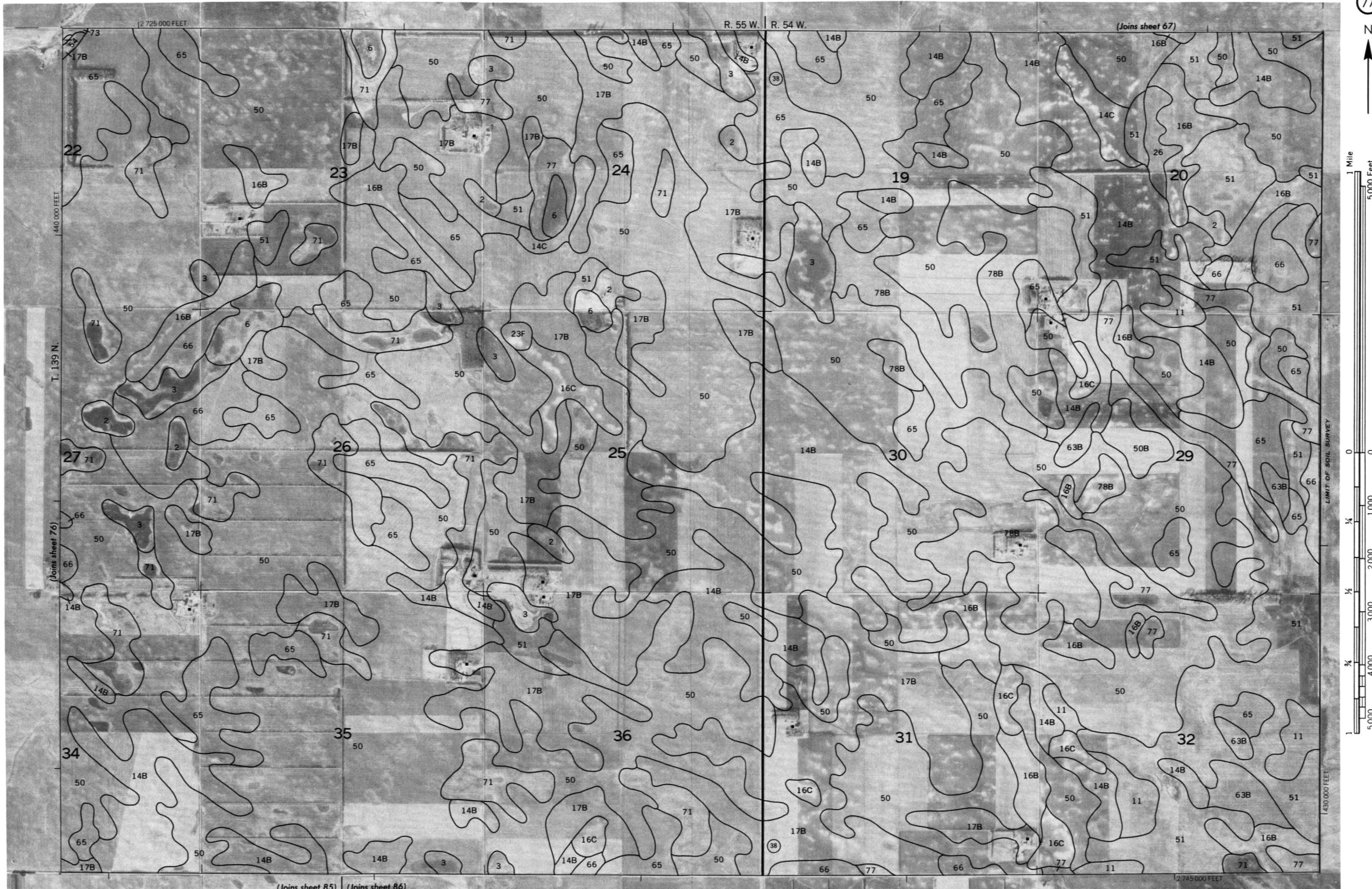


CASS COUNTY AREA, NORTH DAKOTA NO. 75
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

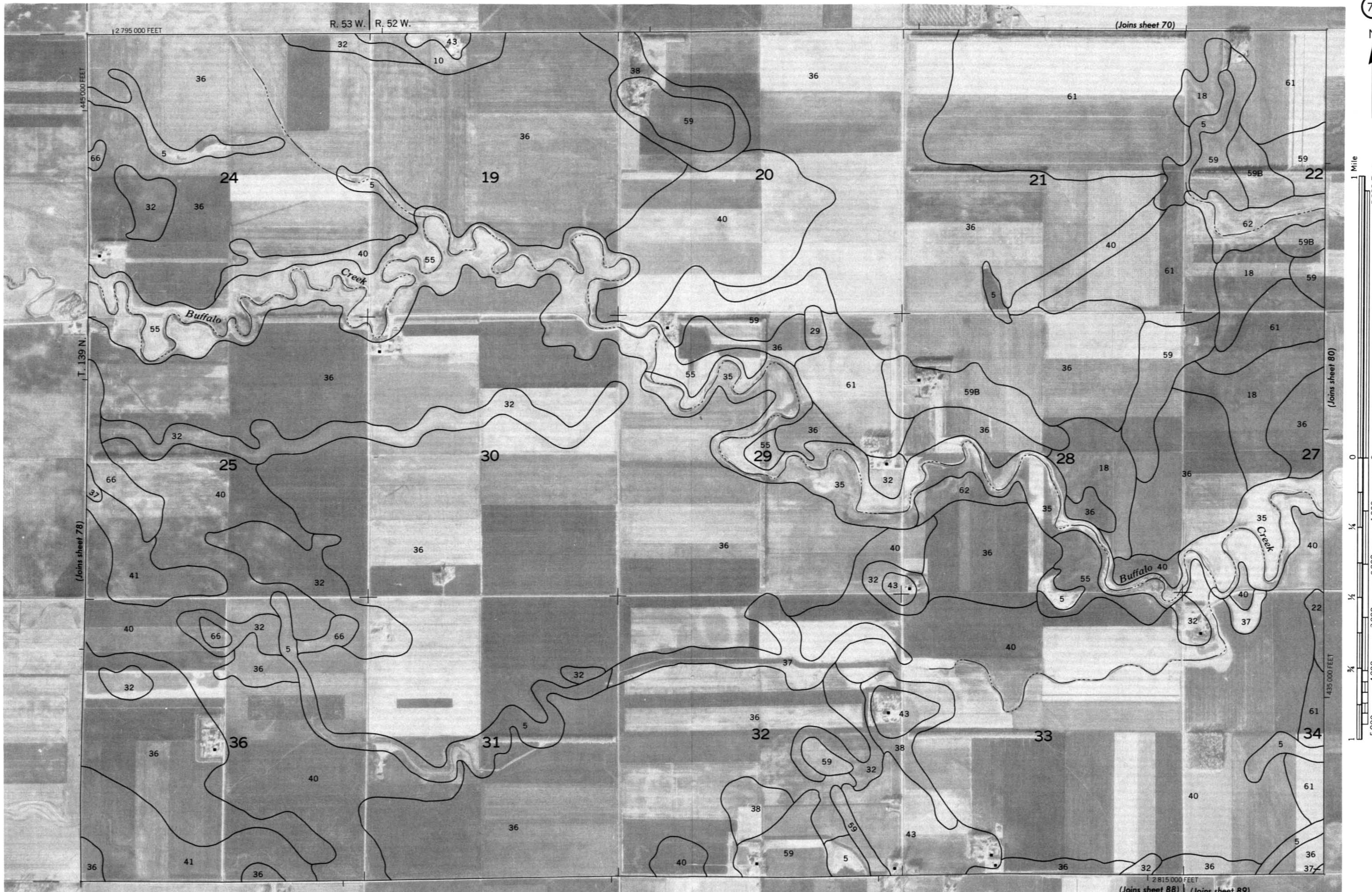
CASS COUNTY AREA, NORTH DAKOTA NO. 76



CASS COUNTY AREA, NORTH DAKOTA NO. 77

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



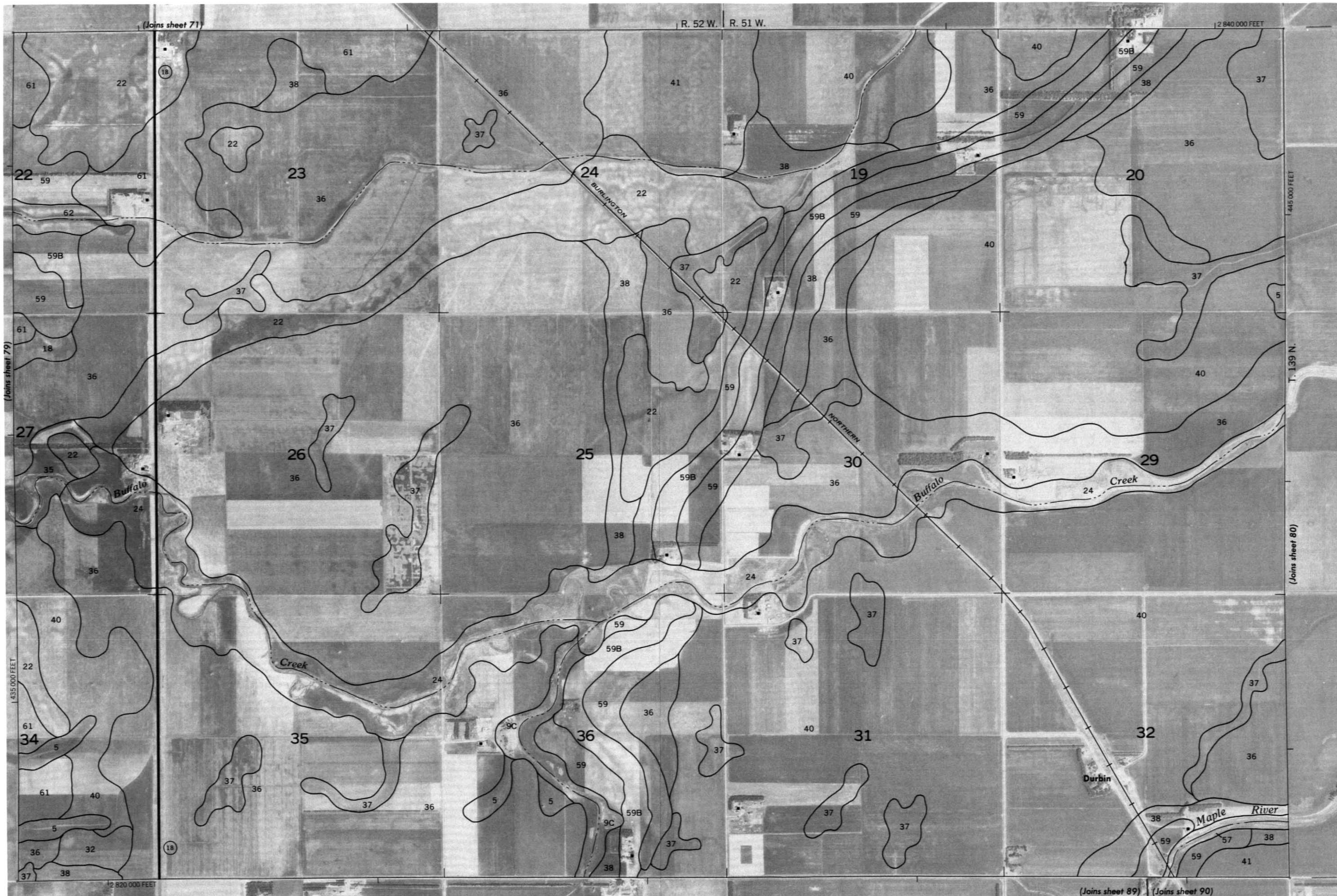
CASS COUNTY AREA, NORTH DAKOTA NO. 79

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

80

N

1 Mile
5000 Feet
Scale 1:20000
0 1000 2000 3000 4000 5000
0 ¼ ½ ¾ 1



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA NO. 81

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

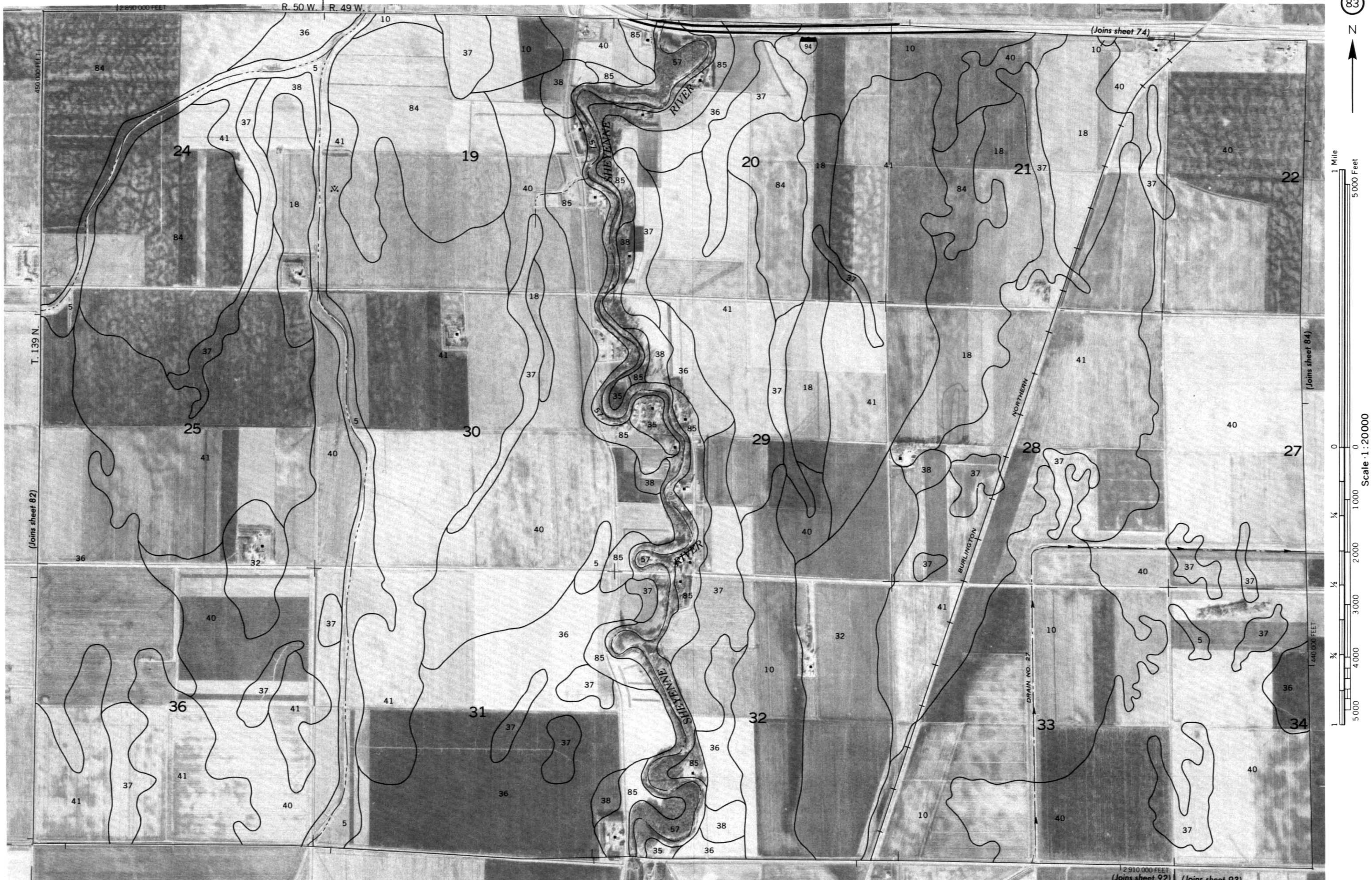
CASS COUNTY AREA, NORTH DAKOTA — SHEET NUMBER 82

N

1 Mile
5 000 Feet
Scale 1:20000
0 1000 2000 3000 4000 5000
0 ¼ ½ ¾ 1

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

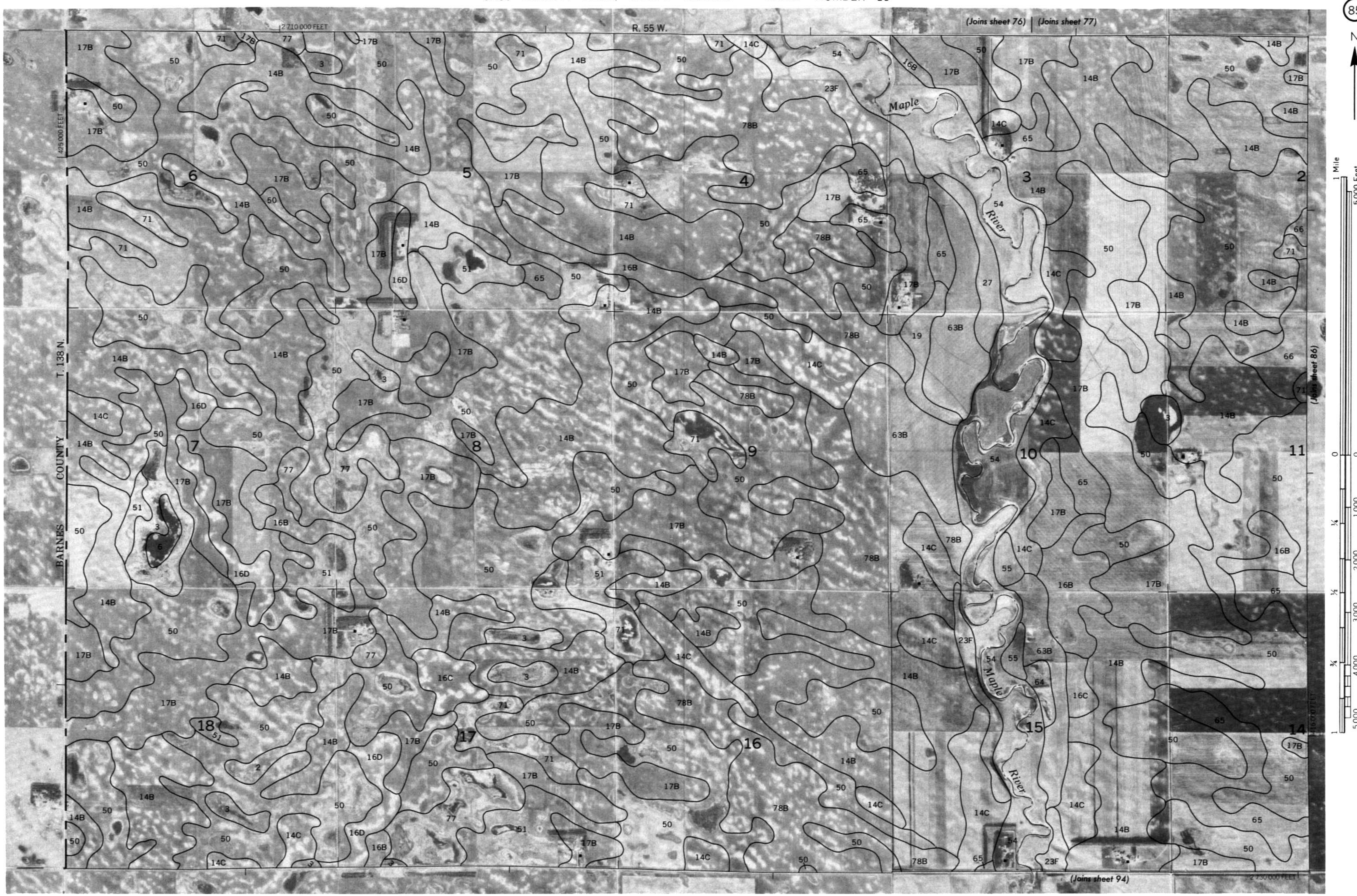
CASS COUNTY AREA, NORTH DAKOTA NO. 82



CASS COUNTY AREA, NORTH DAKOTA NO. 83

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



CASS COUNTY AREA, NORTH DAKOTA NO. 85

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

86

N

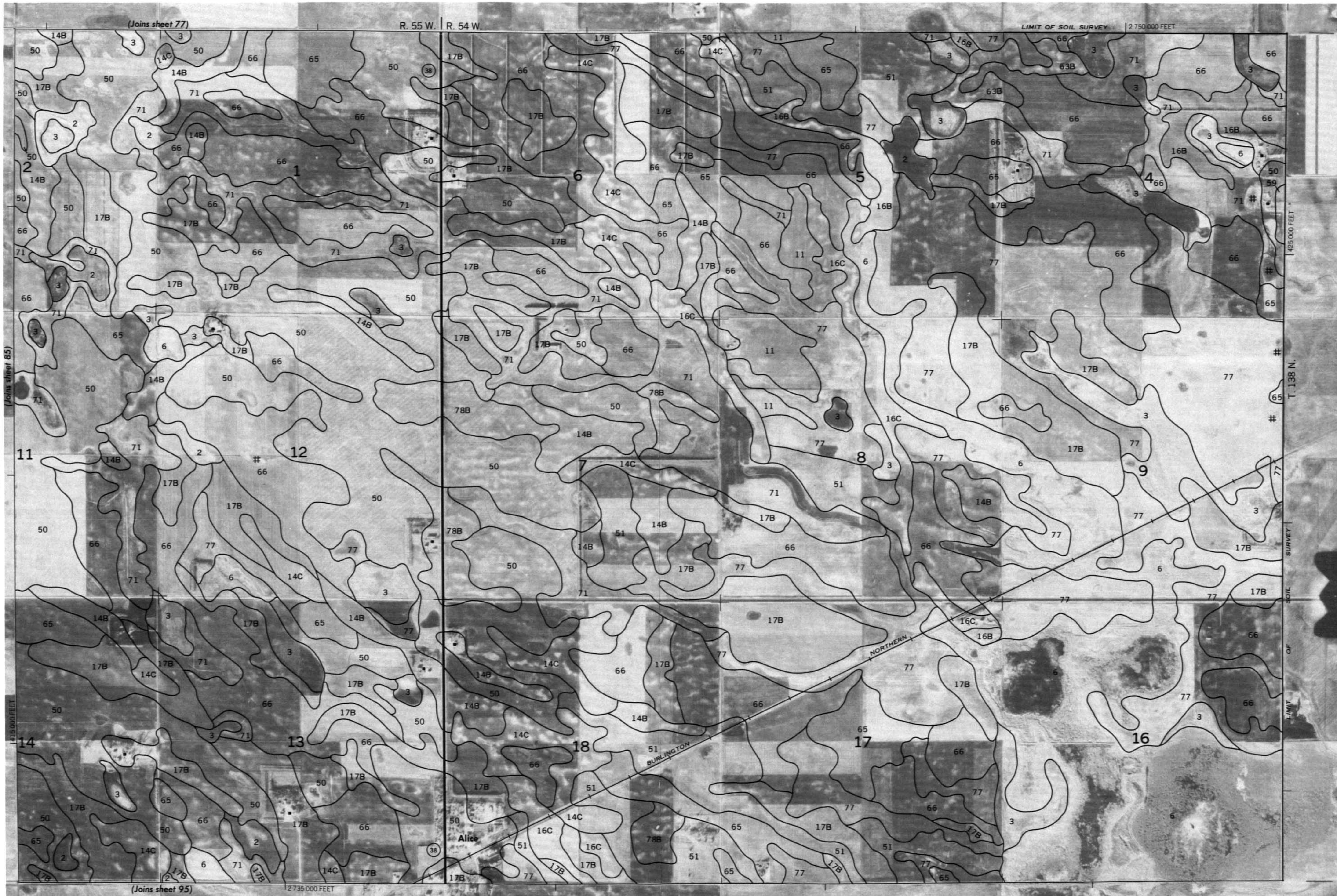
1 Mile

5000 Feet

Scale 1:20000

0 1000 2000 3000 4000 5000 Feet

0 ¼ ½ ¾ 1 Mile



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

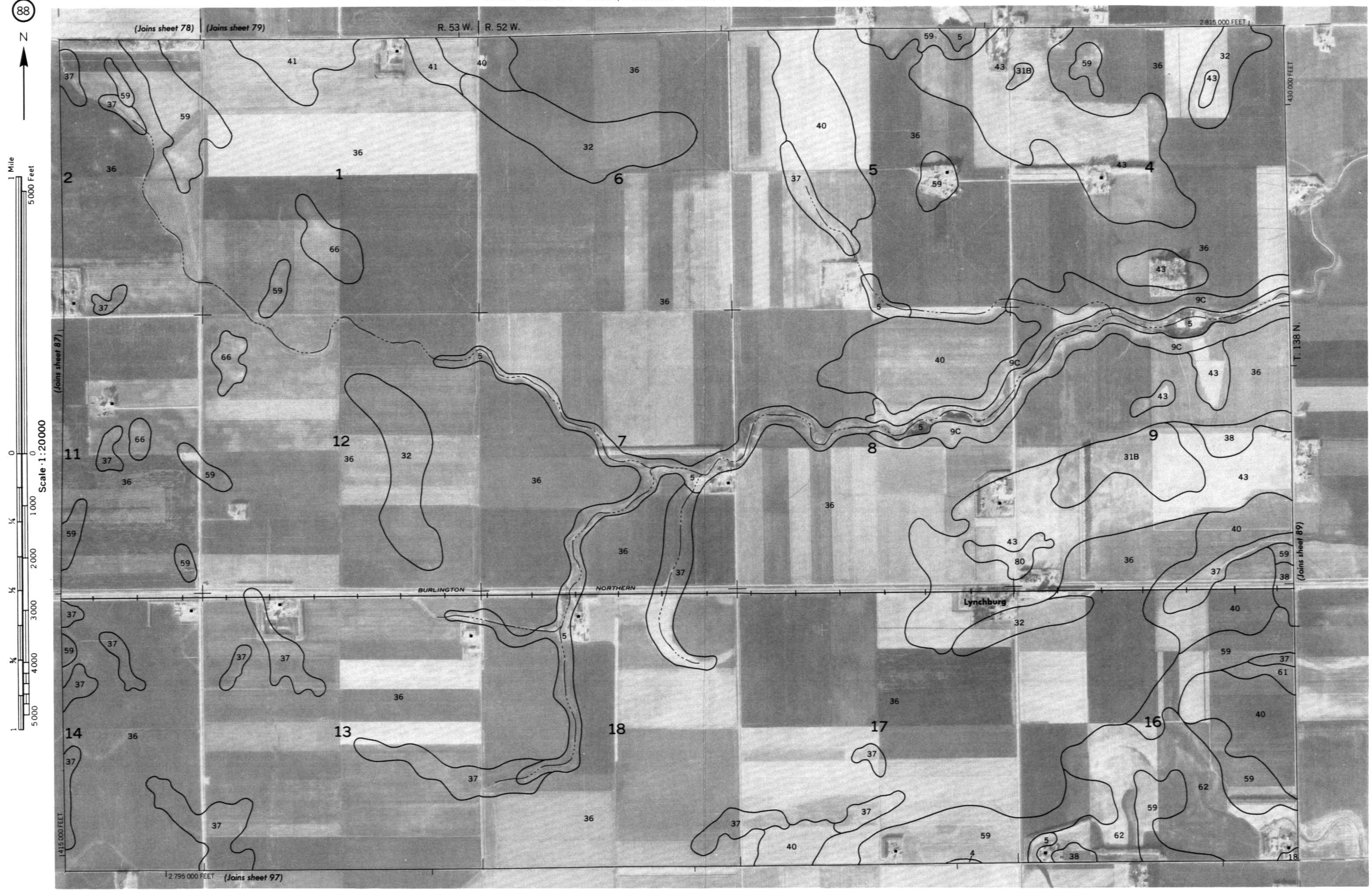
87

N

1 Mile
5000 Feet
Scale 1:20000

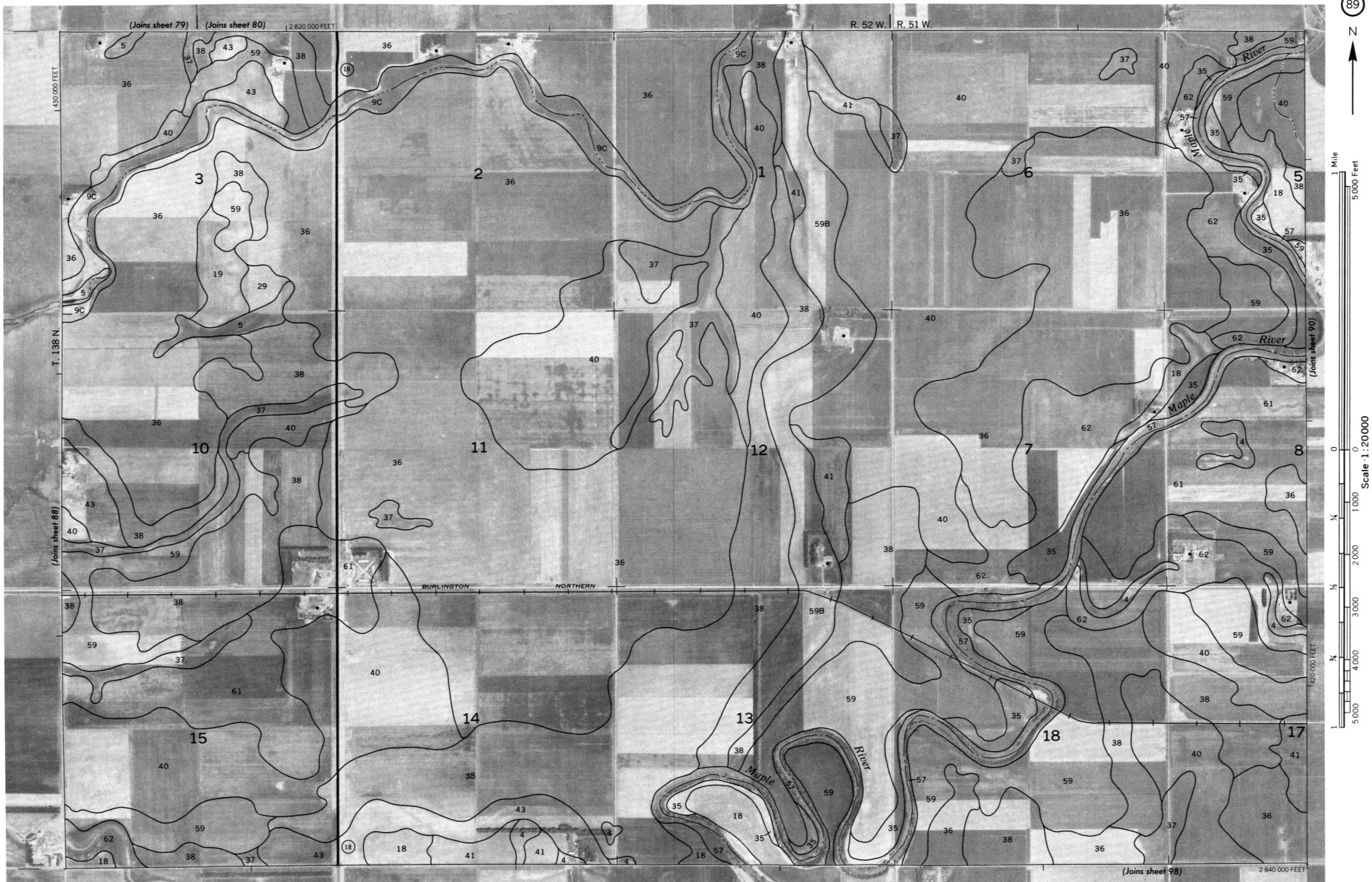
CASS COUNTY AREA, NORTH DAKOTA NO. 87

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



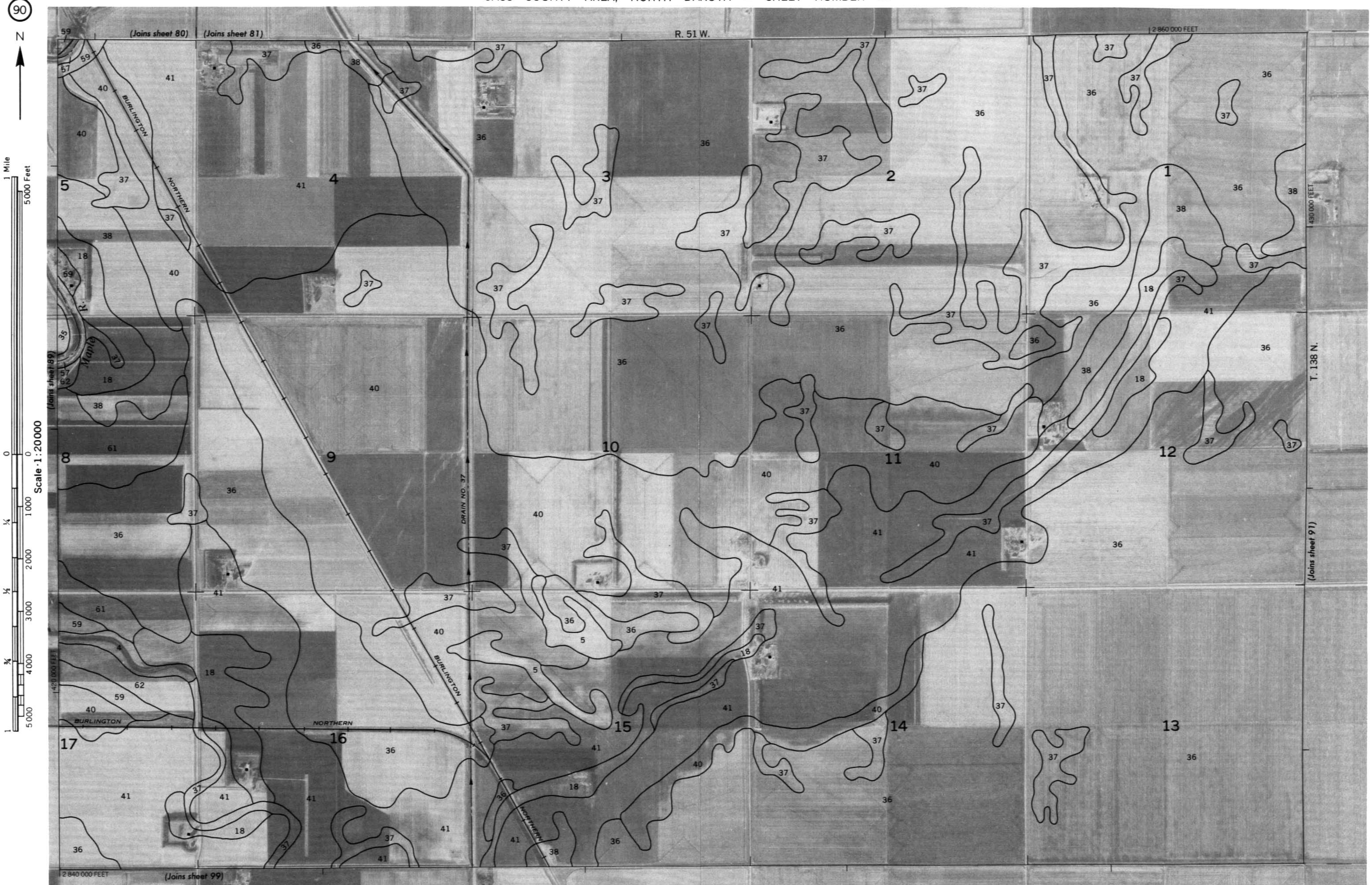
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA NO. 88

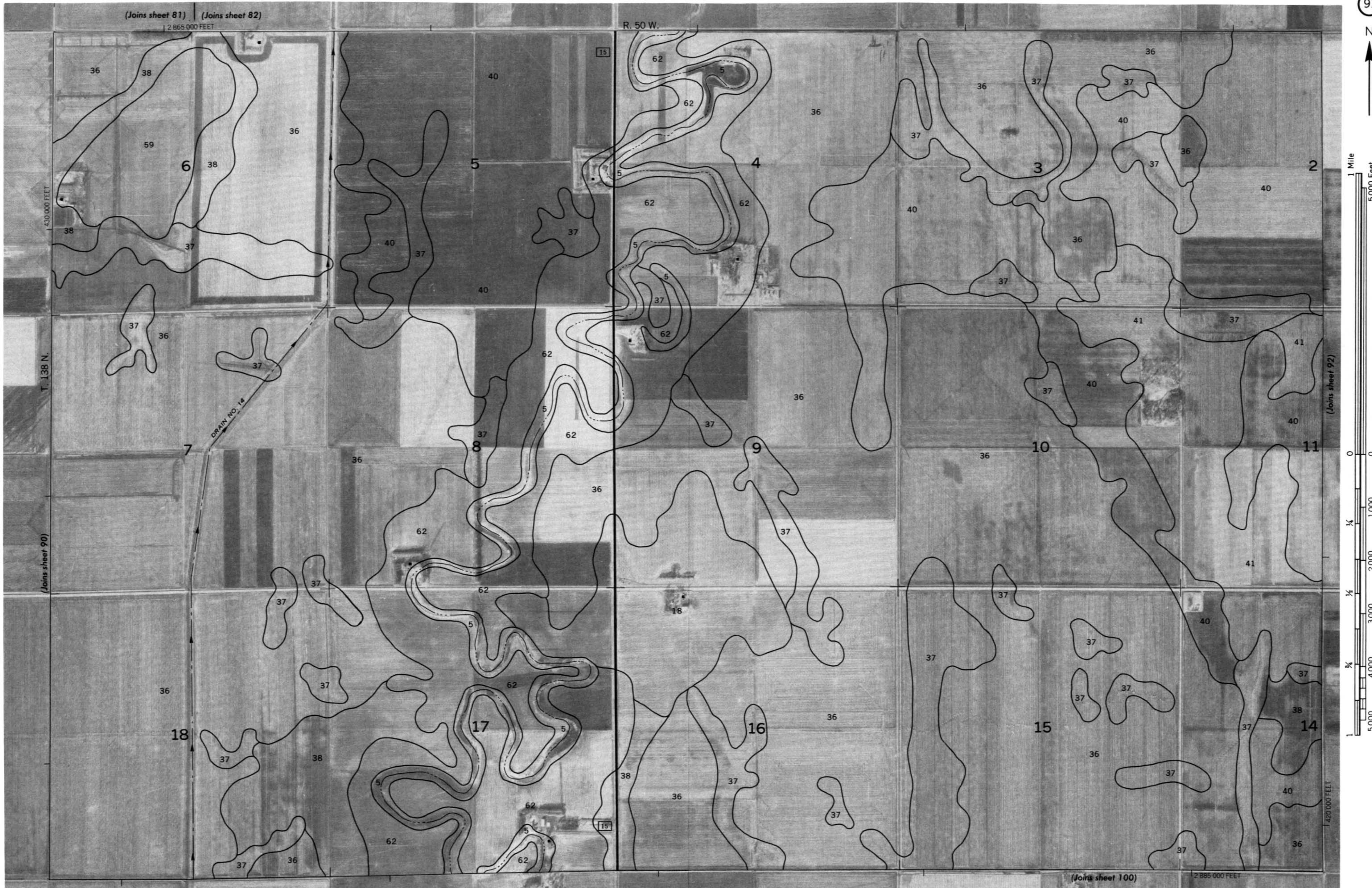


CASS COUNTY AREA, NORTH DAKOTA NO. 89

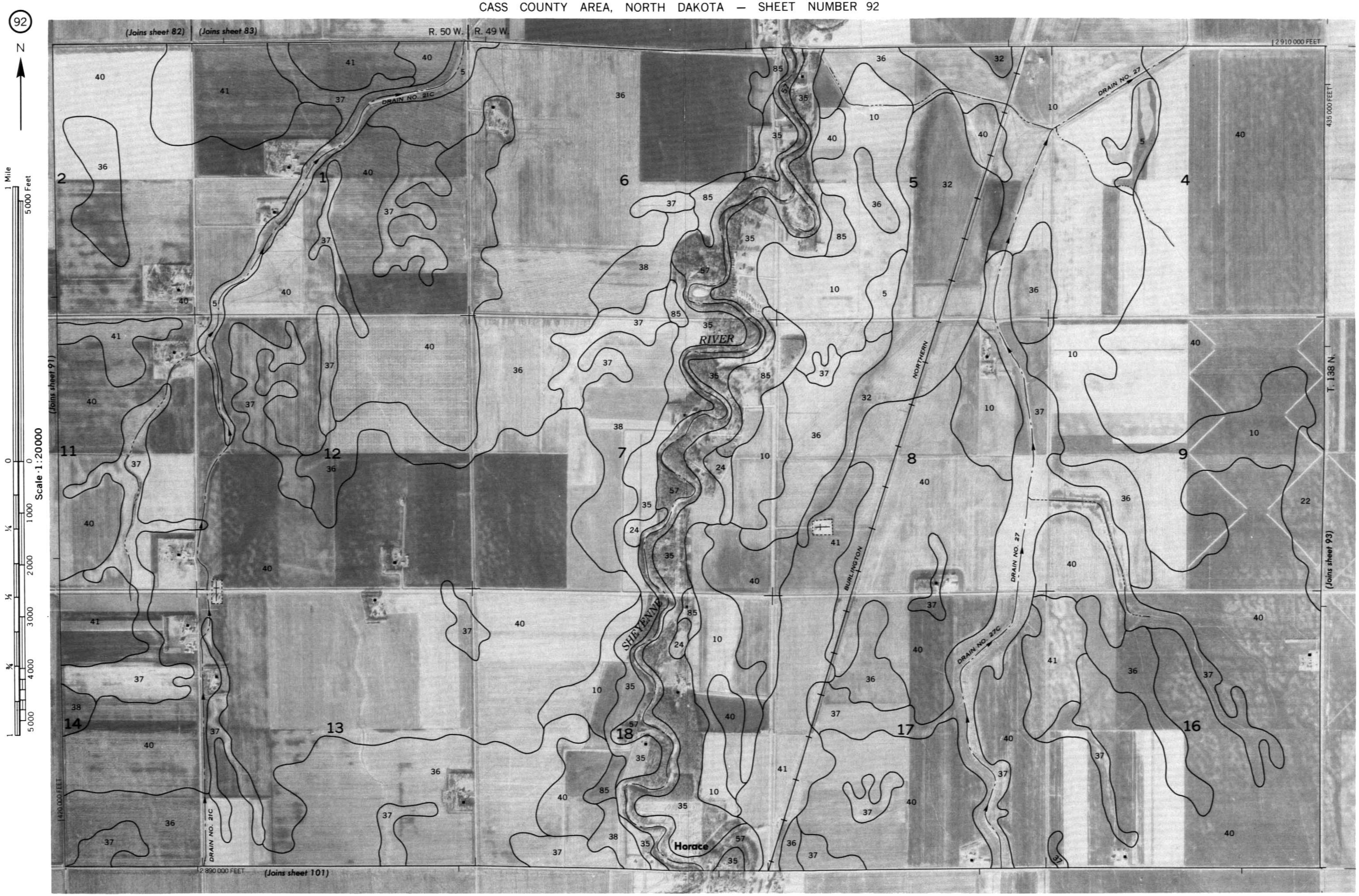
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



CASS COUNTY AREA, NORTH DAKOTA NO. 91
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

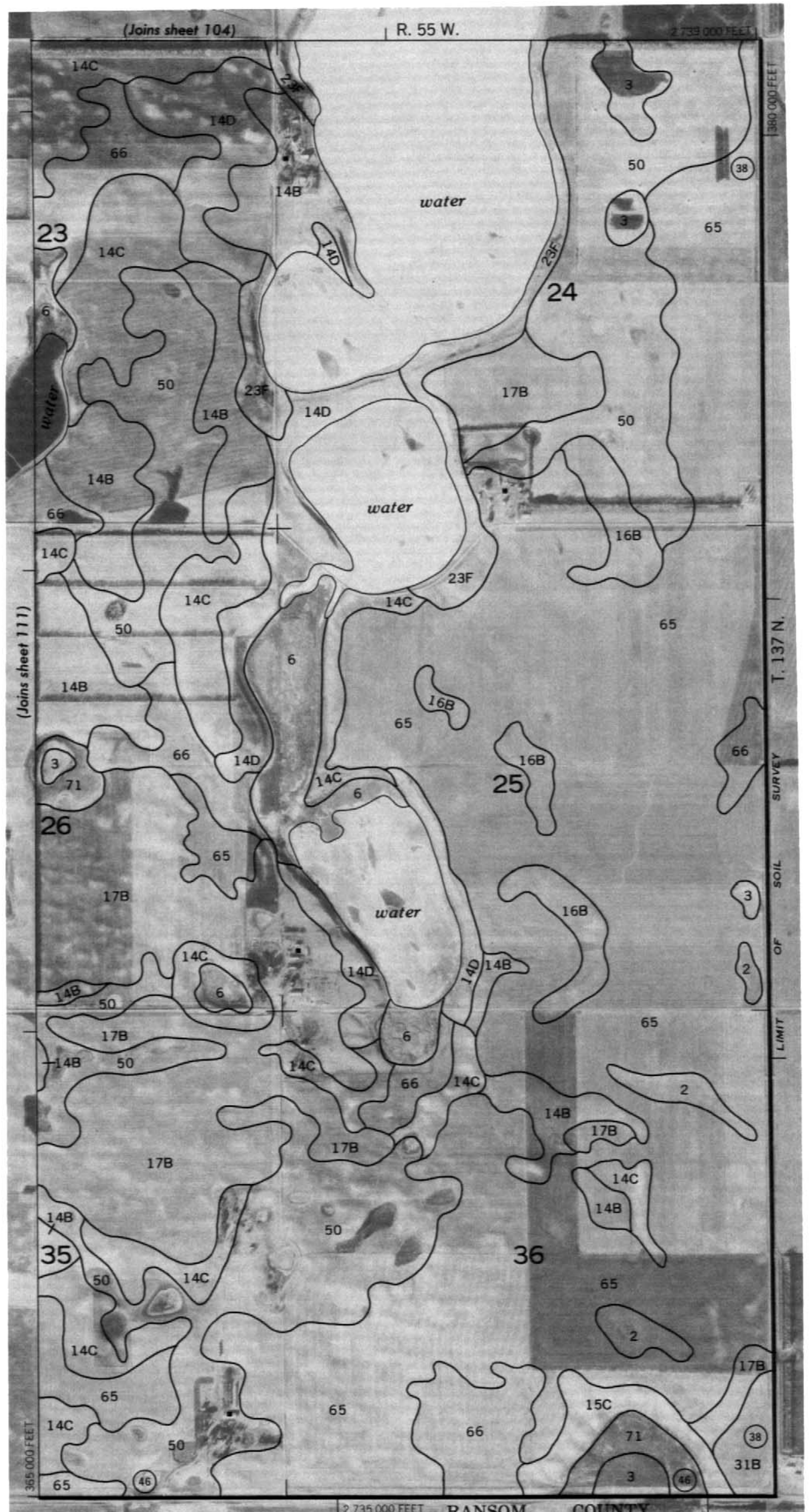
CASS COUNTY AREA, NORTH DAKOTA NO. 95

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

96

N

1 Mile
5000 Feet
0
0
1000
¼
2000
½
3000
¾
4000
1
5000
Scale 1:20000



4000 AND 5000-FOOT GRID TICKS

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

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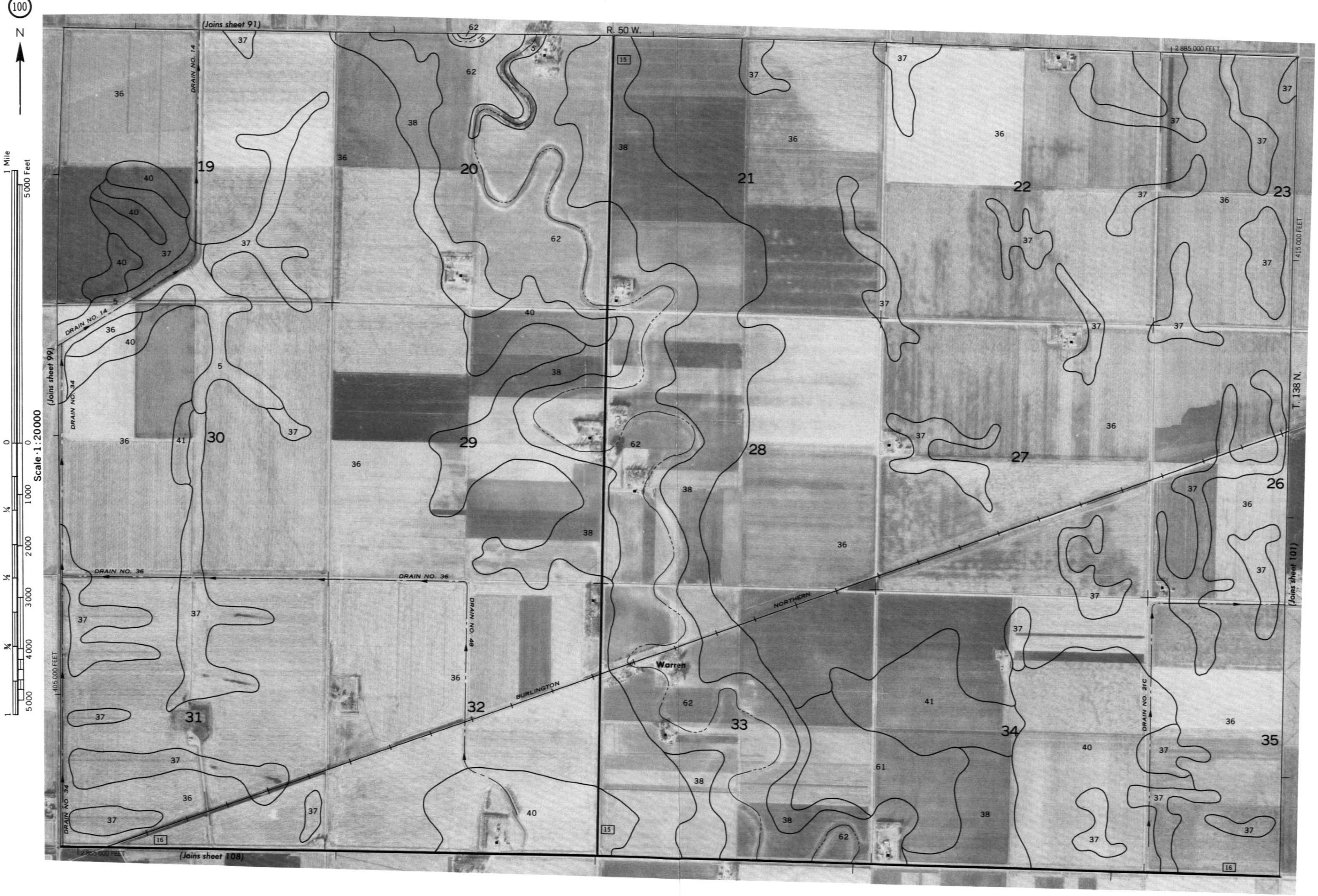
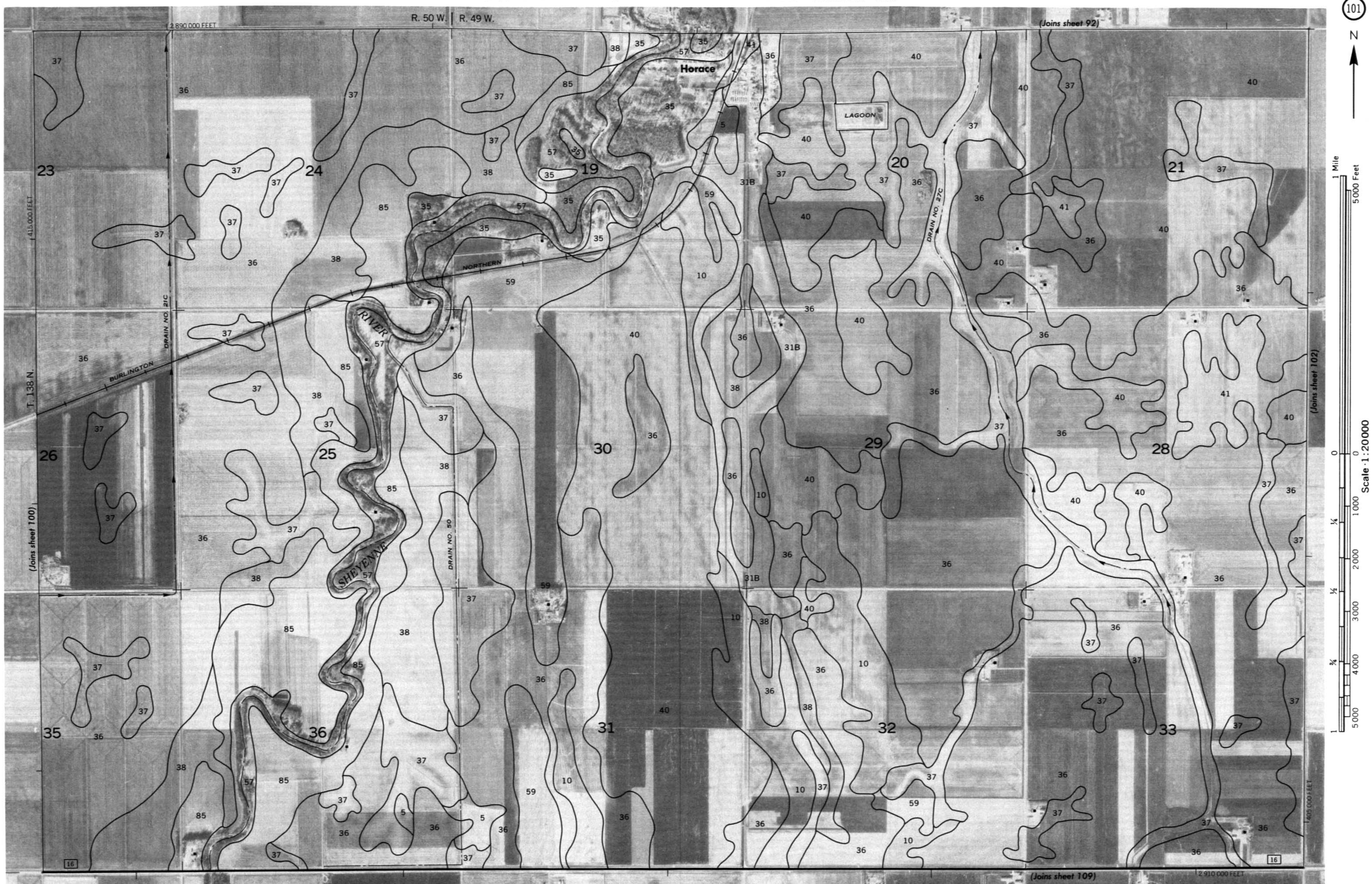
CASS COUNTY AREA, NORTH DAKOTA NO. 98

CASS COUNTY AREA, NORTH DAKOTA NO. 99

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



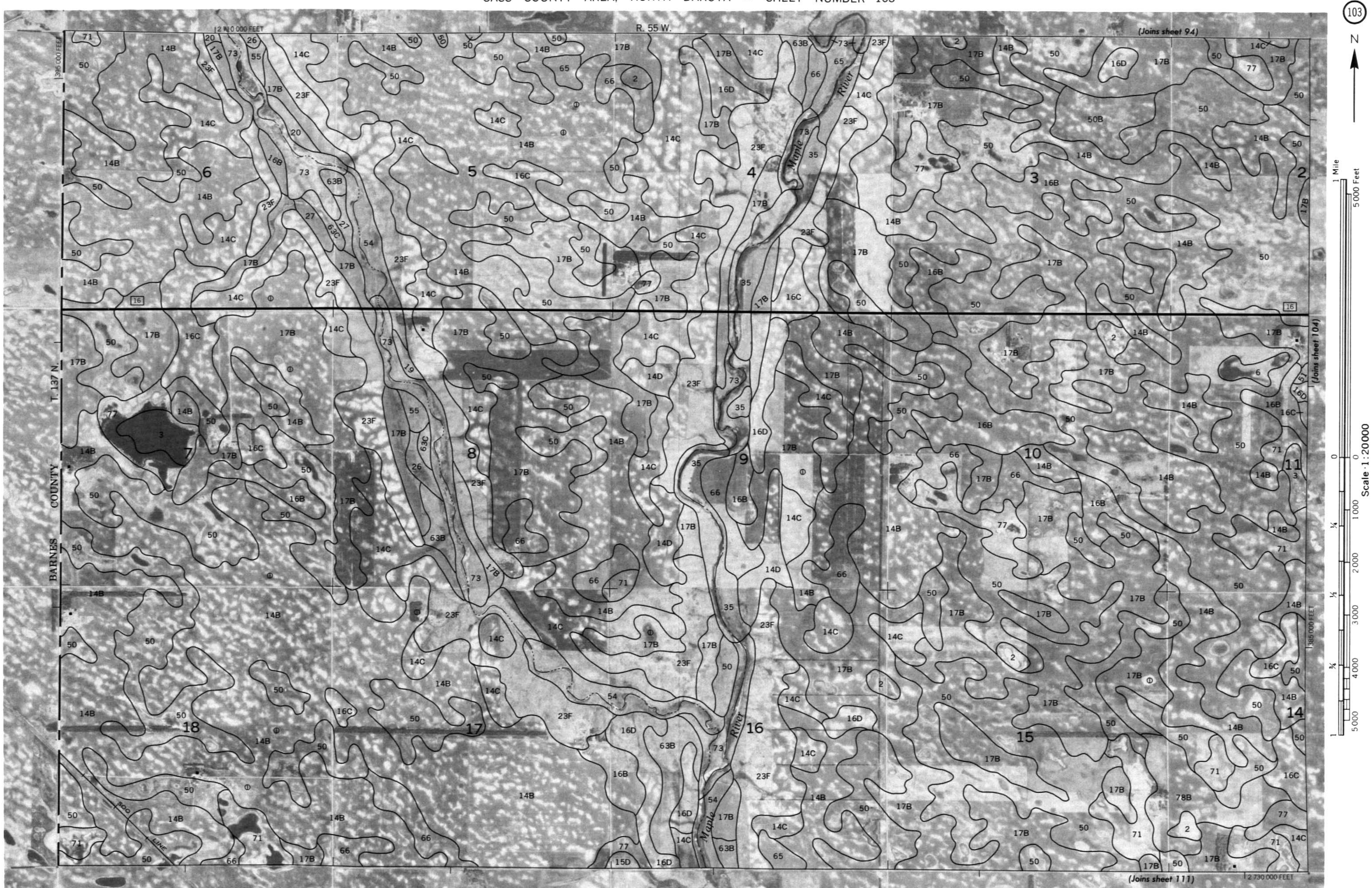
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



CASS COUNTY AREA, NORTH DAKOTA NO. 101

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



CASS COUNTY AREA, NORTH DAKOTA NO. 103

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

(104)

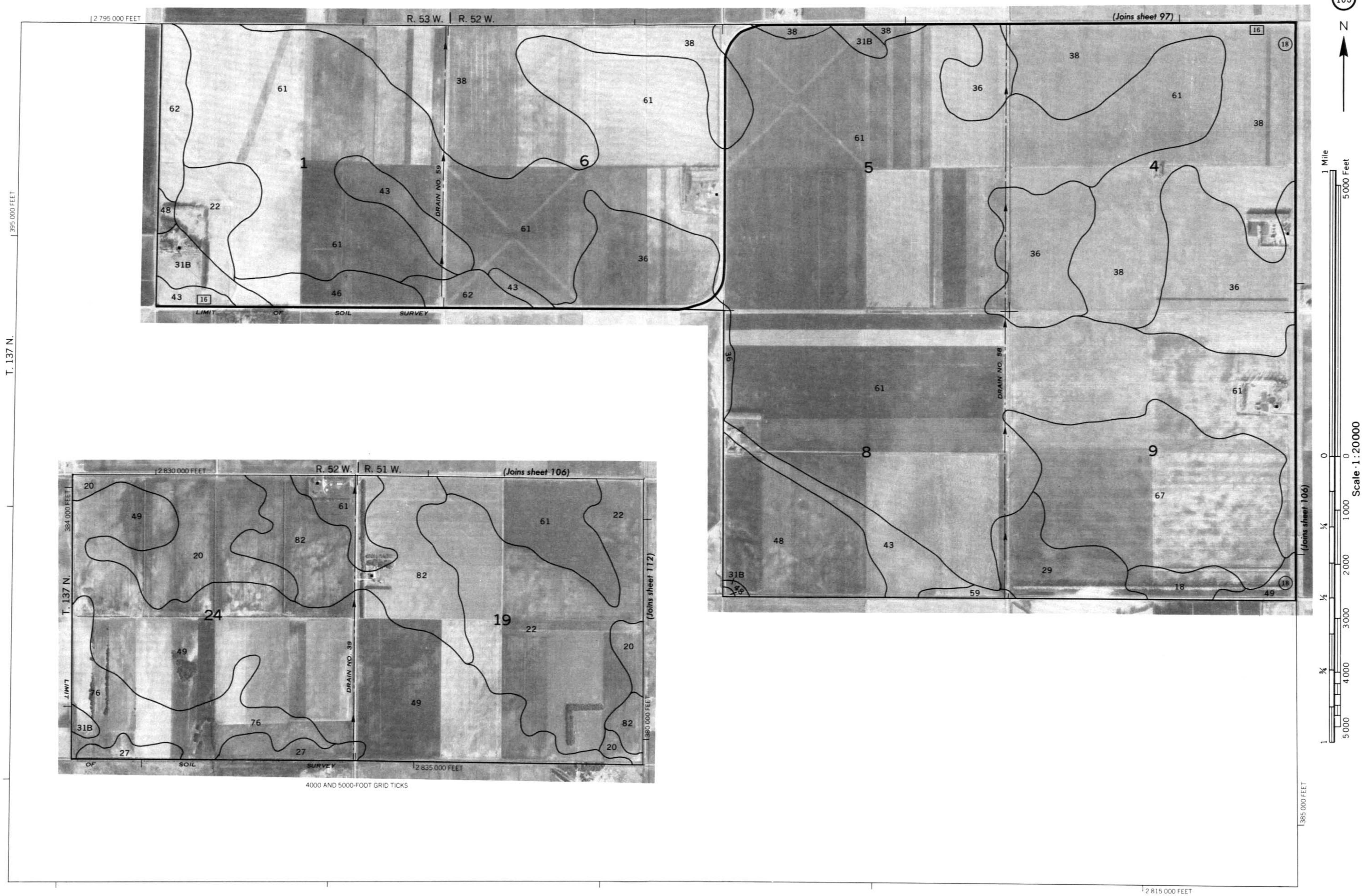
N

1 Mile
5000 Feet
Scale 1:20000
0 1000 2000 3000 4000 5000

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA NO. 105

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA — SHEET NUMBER 107

CASS COUNTY AREA, NORTH DAKOTA NO. 107

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA — SHEET NUMBER 108

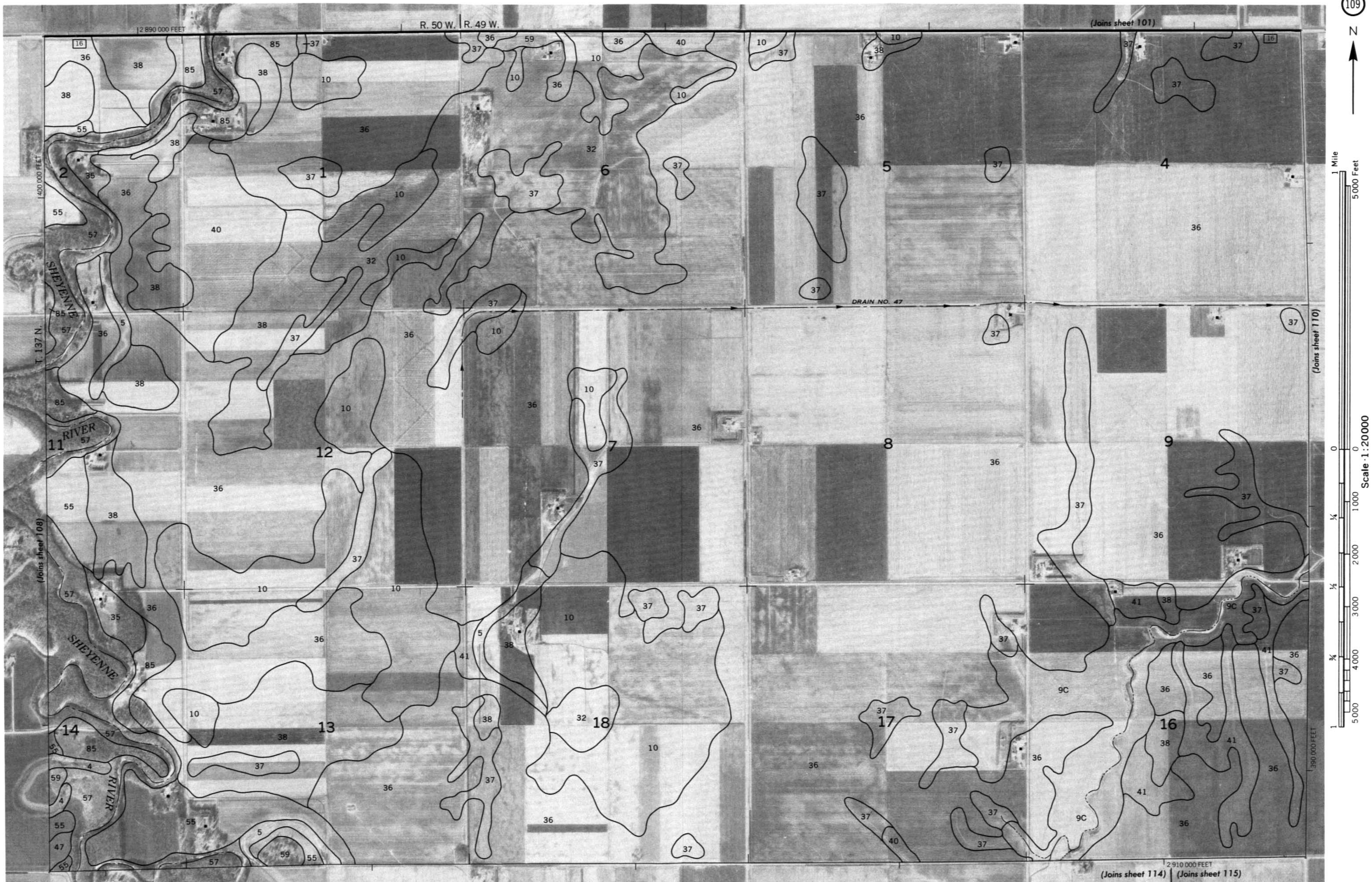
N

1 Mile
5 000 Feet
Scale 1:20000

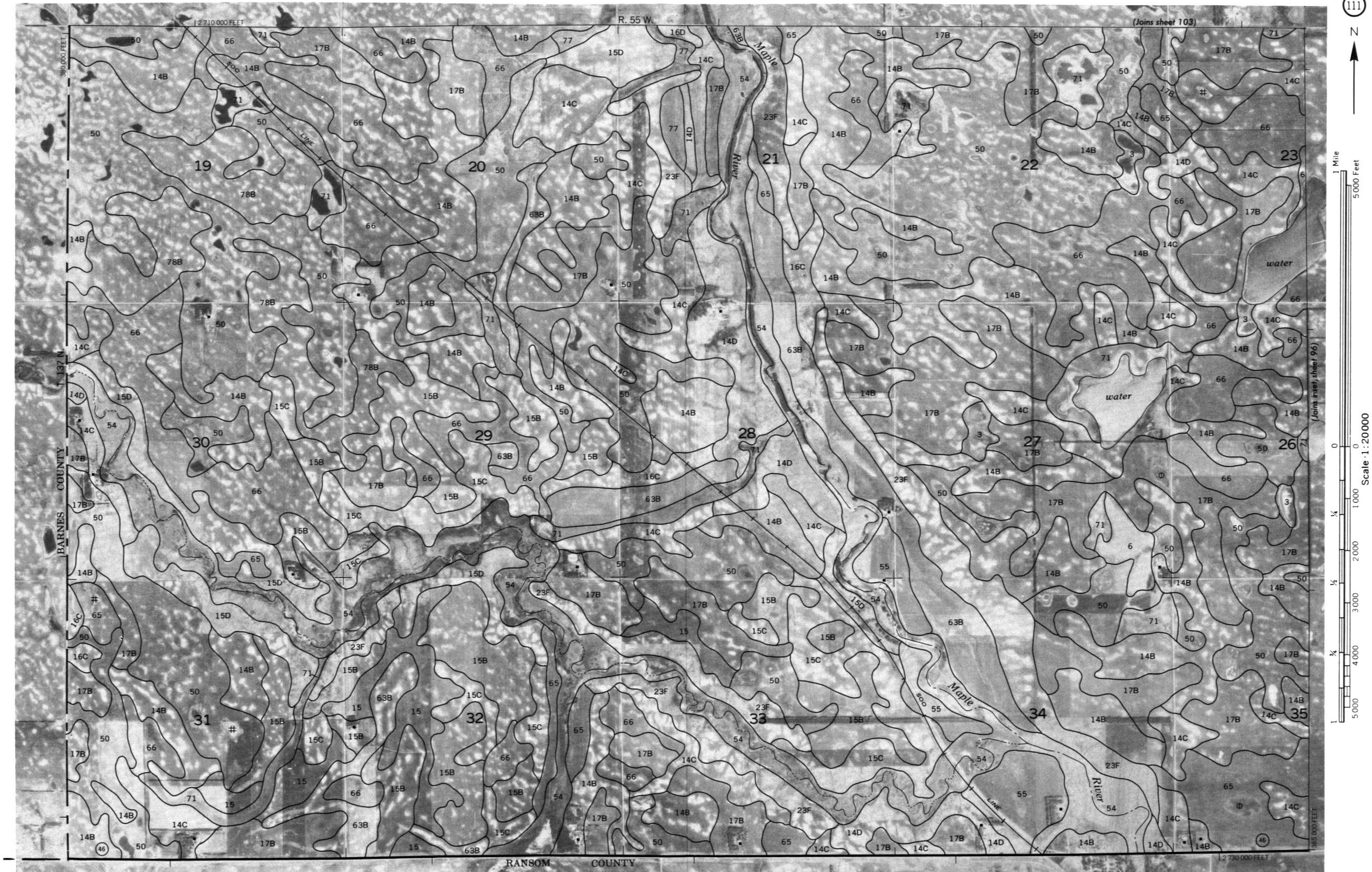
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA NO. 109

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



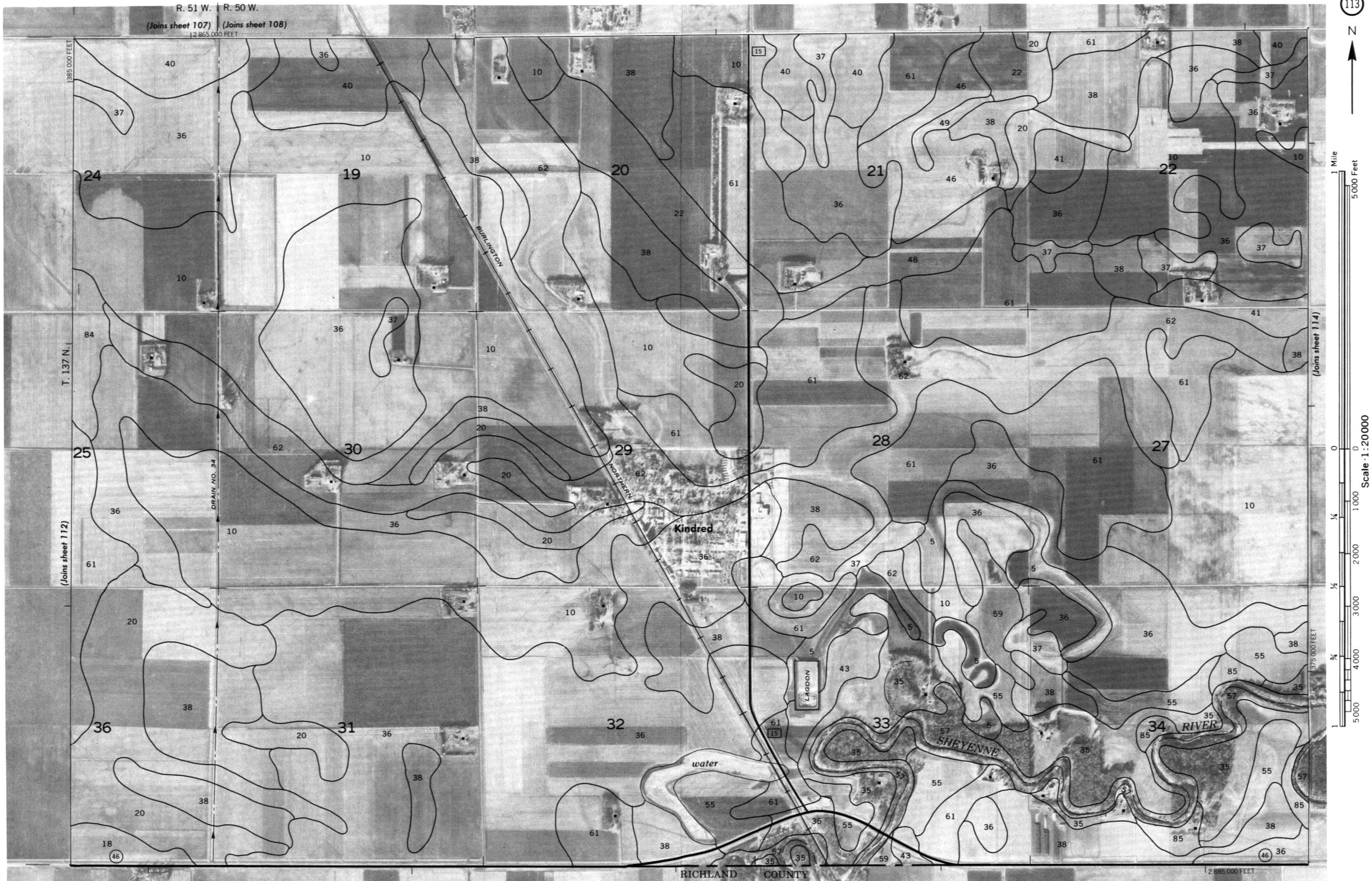
CASS COUNTY AREA, NORTH DAKOTA NO. 111

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA — SHEET NUMBER 112

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA NO. 112



CASS COUNTY AREA, NORTH DAKOTA NO. 113

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

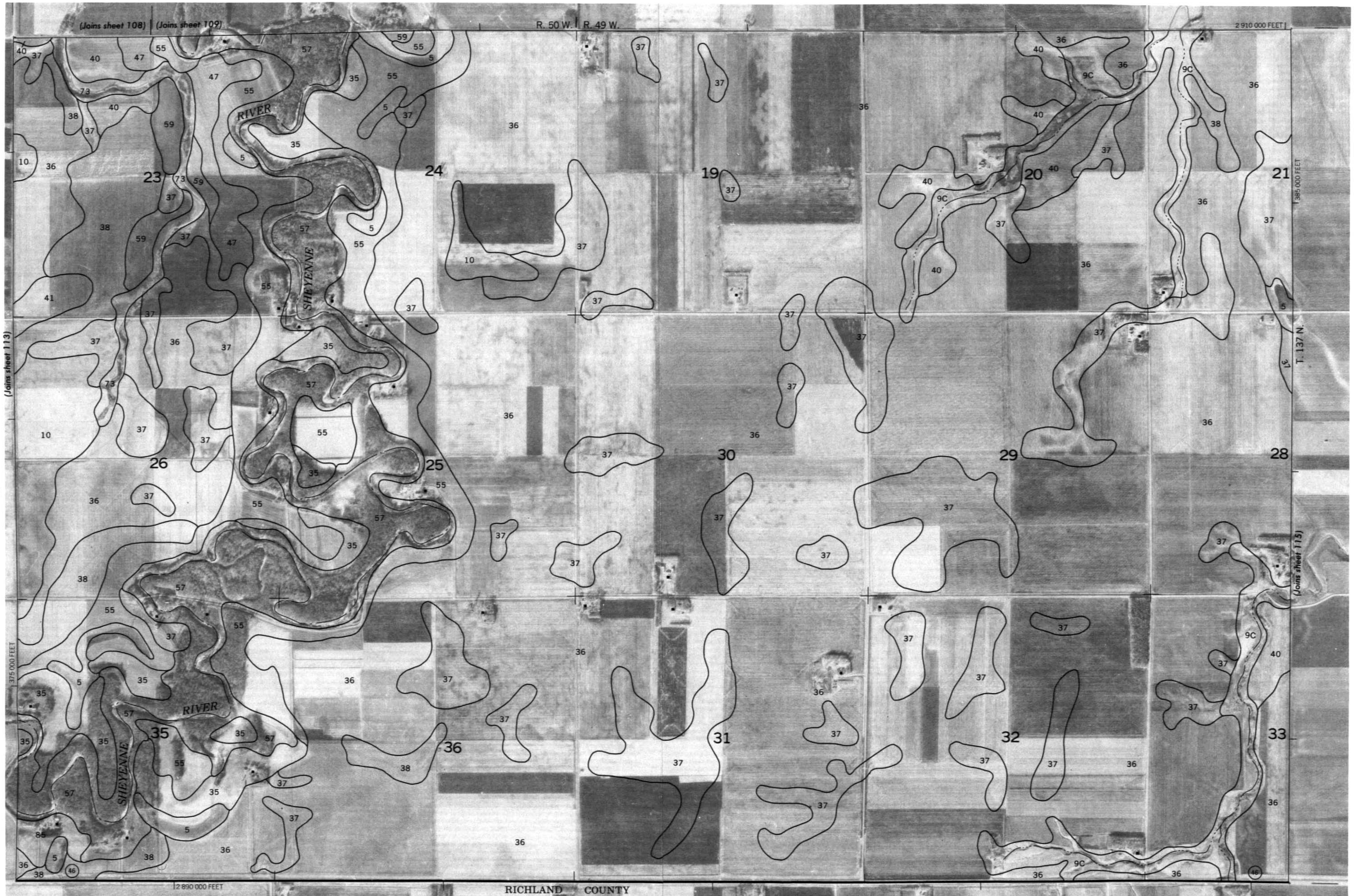
CASS COUNTY AREA, NORTH DAKOTA — SHEET NUMBER 114

N

1 Mile

5000 Feet

Scale 1:20000



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY AREA, NORTH DAKOTA NO. 114

CASS COUNTY AREA, NORTH DAKOTA NO. 115
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.